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Goal Program Mechanism of Managing Science, Technology

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[Article by Doctor of Economic Sciences Professor N. Komkov under the rubric "Scientific and Technical Progress": "On the Goal Program Mechanism of the Management of Science and Technology"]

[Text] The strategy of accelerating the socioeconomic development of the country, which was outlined at the April (1985) CPSU Central Committee Plenum, received subsequent development in the materials of the conference on questions of the acceleration of scientific and technical progress and further specification in the decisions of the 27th CPSU Congress. The adopted direction of the utmost intensification of production on the basis of the achievements of scientific and technical progress requires the carrying out of the radical restructuring of the prevailing economic organizational mechanism of the management of science and scientific and technical progress in general. The essence of this reform is as follows: it is necessary to shorten drastically the duration of the cycle of the development and production of innovations (for the machine building complex it is planned to shorten the time of the development and assimilation of new equipment to one-fourth to one-third) with the simulation rapid increase of the output of products that have been assigned to the highest quality category (it is planned to increase the share of industrial products of the highest quality category during the 12th Five-Year Plan by 1.9- to 2.1-fold). An important element of the planned reform is the increase of attention to the comprehensiveness of the innovations being developed and to the development and large-scale use of base technologies. It is necessary in a short time to implement urgent decisions on the streamlining of the economic organizational mechanism of the management of science and scientific and technical progress.

Far from all the components and elements of the prevailing system of the planning and management of science and scientific and technical progress satisfy the requirements of the acceleration and the increase of the quality of research and development. It is well known that this system has a hierarchic structure (the national economic, regional, and sectorial levels, as well as the level of organizations, associations, and enterprises) and the corresponding planning horizons (the comprehensive program of scientific and technical progress of the USSR, the Basic Directions of Economic and Social Development for specific periods, five-year and annual plans). In spite of the fact that the entire cycle of scientific and technical development, which includes basic and applied research, development, and the introduction and mass dissemination of new equipment and technology, is encompassed by the prevailing system, its formed economic organizational mechanism does not completely satisfy the requirements of the shortening of the duration of the cycle and the increase of the qualitative level of the equipment and technology, which are being developed and produced.

The increase during the 10th and 11th Five-Year Plans of the attention to compiling long-range forecasts and plans of scientific and technical development had the result that at present the target assignments of superior organs—sectorial ministries and departments—serve as the basic source of the formulation of proposals on the plans of organizations, associations, and enterprises. With allowance made for them, as well as on the basis of their own interests the corresponding scientific units formulate proposals on the plans, which are summed up in succession first at the level of scientific research institutes, design bureaus, scientific production and production associations, and enterprises, and then at the sectorial and national economic levels. Under the conditions of the existing practice of management, when the basic resources (scientific personnel, equipment and instruments, production areas, and so on) have already been distributed among organizations, associations, and enterprises, the fundamental link between the posed goals and the resources necessary for their achievement is actually lost. One should add to this the lack of the proper appraisal of scientific research plans and scientific and technical programs, which should be provided by the staff of technical administrations (and administrations of scientific research work) of ministries with the enlistment of leading specialists. All this has the result that enterprises, ministries, and departments frequently cannot resist the "drawing out" of the implementation of research themes, designs, and assignments of programs for the entire five-year plan and the inclusion in the plans of minor and secondary tasks, which are conducive only to evolutionary changes of the range and technical and economic indicators of equipment and technological processes.

The prevailing system of the planning and management of science was developed mainly by the strengthening of the mechanism of departmental "vertical" management. The trends toward the improvement of the management of the entire cycle of scientific and technical development, which includes the search for, conception, development, production, and use of new equipment and technology, began to appear only with the introduction at the all-union level first of coordinating plans on the solution of the most important problems, and then of scientific and technical programs, the organization of scientific production associations, the strengthening of cost accounting relations in science, the changeover of several sectors to comprehensive planning, and the development of innovations on the basis of supply orders. However, the steps taken in this direction were not always of a comprehensive nature and were not properly checked during experiments, their implementation was not accompanied by mandatory organizational reform and the effective monitoring of fulfillment, therefore, they yielded only partial success. Large-scale

reform, which is aimed at the improvement of the interaction of the academic, sectorial, and VUZ sectors of science and the extensive use of new advanced forms of the organization of scientific activity, which make it possible to solve in the shortest possible time major intersectorial scientific and technical problems, has been planned.

It is necessary that the increase of the effectiveness of "horizontal" interrelations would be carried out at the same time as the improvement of the traditional methods of "vertical" management and would be based on the extensive dissemination of the methods of goal program management and the taking of organizational steps on the most complete use of their advantages; on the improvement of the structure and technology of the drafting of plans on the development of science and technology at all levels of management; on the development of automated control systems of development in organizations and enterprises, sectors, departments, and regions, as well as at the statewide level; on the increase of the effectiveness of the existing organizational forms and the introduction of new organizational forms of the link of science with production; on the radical change of the management of scientific and technical progress with the changeover to the mass use of automated information technology (the use of computers, information facilities, mathematical economic models, and others).

The formulation and fulfillment of scientific and technical programs at the all-union level have been carried out for three five-year plans. As a whole the experience obtained in this direction has yielded positive results. However, many advantages of goal program management as an advanced form of the organization of the interaction of science and production are being used inadequately. In the goal program methods of the management of scientific and technical development there are many omissions: in case of the formulation of programs their clients and the main developers devote inadequate attention to the substantiation of the needs, goals, and tasks, therefore, the negative practice of formulating programs "from below" on the basis of the summing up of the proposals of organizations and enterprises predominates; many of the programs do not have a clear idea and a single core, which determines the directions of the solution of the problem, which are necessary for the achievement of the goal; the specific assignments are not always aimed at the obtaining of high economic results; the influence of individual all-union programs on the pace of scientific and technical progress and the scale of retooling is small. There is no effective system of the resource supply of all-union programs. The priority financing, which was planned for them, during the 10th and 11th Five-Year Plans was often upset and did not "reach" the specific performers; many all-union programs of the 11th Five-Year Plan, which have been proposed for inclusion in the plan of the 12th Five-Year Plan, are of a narrow sectorial nature; the majority of them are aimed at the development of unique innovations which are limited in the scale of their application. Here equipment and technology of mass application, which constitute the bulk of the fixed capital, are often lost sight of. The losses from the use of imperfect models are quite large.

Let us dwell on the factors, which give rise to such shortcomings, and the possible means of their elimination. The analysis of the causes of the deviation of the actual results of the fulfillment of the assignment of all-union problems from the indicators envisaged in the plans showed that in most cases this is due both to the internal inconsistency of the procedural documents, which should ensure the coordination of the corresponding indicators of the programs and plans, and to the violation of the technology of formulating the programs and plans, which was established by these documents. Frequently the operations, which are envisaged in programs, either are not included in the plans of ministries and organizations or are not reported to the performers. The assignments of the programs are not coordinated in good time with the plans of introduction, capital construction, and the production of components. All this is a consequence of organizational errors in the formulation of the programs, and especially the violation of the requirement of the mandatory inclusion of their assignments in the plan of economic and social development.

Along with the carrying out during the 12th Five-Year Plan of the extensive organizational reform of the system of management of scientific and technical development it is necessary to devote special attention to the qualitative substantiation and multivariant analysis of the plans of scientific research work and scientific and technical programs. The improvement of this practice will make it possible to identify effective versions and the organizational conditions for the substantial shortening of the duration of the cycle of scientific and technical development and the increase of the level of the innovations being developed.

The fact that the basic attention at the initial stage was focused on the preparation and comprehensive discussion of procedural materials, in many respects promoted the increase of the quality of the long-term scientific and technical programs of the development of electric power engineering. Here first of all the proper mastering and precise observance by the participants of the process of the formulation and implementation of the basic ideas, principles, and conditions of the adequate use of goal program management is important.

As experience shows, the mastering of a specific method of management directly by researchers, developers, and the producers of new equipment themselves should be regarded as the key unit in the improvement of scientific and technical programs. Goal program management is not only new planning forms. It requires first of all a different psychology, a new manner of thinking of managers and developers, in which technical and technological, economic and organizational problems are closely interconnected. However, it proves to be difficult to

reform quickly and to reject the obsolete approach. Now it is impossible to solve complex problems effectively without special methods of organization and management.

Many leading institutes of the USSR Academy of Sciences (the Institute of Chemical Physics, the Institute of Control Problems, and others), sectorial scientific research institutes (the VNIIstroypolimer, the Institute of Chemical Reagents and Ultrapure Chemical Substances), as well as higher educational institutions of the country (the Moscow Institute of Petroleum and Gas, Gorkiy State University, and others) are organizing the solution of the most important scientific and technical problems in strict conformity with the principles of goal program management.

The need for the radical change of the psychology of thinking of executives of ministries and departments, organizations and enterprises and of the system of management of the national economy, which formed in an evolutionary manner, was urgently posed at the June conference in the CPSU Central Committee on questions of the acceleration of scientific and technical progress, as well as at the 27th CPSU Congress in connection with the transition to the qualitatively new stage of the socioeconomic development of the country. In the middle of the 1970's at the initial stage of the assimilation of the new form of the planning and organization of scientific and technical development on the basis of goal program methods many ministries and departments treated their use formally, attempting to adapt them to the traditional system of management, without changing it in essence. The analysis made in early 1985 of the practice of goal program management in many leading sectors of the national economy confirmed this. The attitude of a number of executives of ministries and their main administrations toward this analysis is indicative: the majority of those, who only used the programs formally or even evaded such an analysis in their ministry, were before long justly criticized in the central press for the committed errors in scientific and technical development (the Ministry of Ferrous Metallurgy, the Ministry of the Petroleum Refining and Petrochemical Industry, the Ministry of the Chemical Industry, the Ministry of the Petroleum Industry, and others). All this once again confirms the fact of the existence of a close connection between high production indicators, the constant attention of executives of departments to the technical development of sectorial technologies, and a well-organized system of the management of scientific and technical development. The breaking of any link in this chain leads to substantial losses of the pace of scientific and technical development for a long time.

Under the conditions of the commenced reform of the entire system of management of scientific and technical development the role of the State Committee for Science and Technology in the area of the formulation and implementation of a unified concept of the goal program management of scientific and tehnical development in the country is increasing significantly. It should provide procedural supervision of the elaboration of sectorial and departmental methods on the improvement of the economic organizational mechanism of the solution of intersectorial and sectorial scientific and technical problems with the use of the basic elements of goal program management.

Special attention should be directed to the increase of the soundness and quality of the programs being formulated. At present neither the State Committee for Science and Technology nor the organs of sectorial management, to which the duties of the main organs for the corresponding programs have been assigned, in many cases are making a multivariant analysis of the possible alternatives and are making the necessary calculations and analysis of the economic indicators, which are envisaged in the programs. Therefore, the formal monitoring of only the dates of fulfillment of individual assignments without the proper monitoring of the cost of work often leads to the groundless "writing off" of expenditures which have no bearing on the programs. In order not to allow such negative phenomena it is necessary, first, when selecting programs to take into account the interconnection of the indicators "the anticipated impact—the cost—the time." Sectorial organs themselves should make such calculations, while the State Committee for Science and Technology is obliged to check their correctness for the programs that are being included among the all-union programs. Second, it is necessary to increase the level of the procedural support of the main developers of the programs—ministries, scientific production associations, production associations, and organizations. For this the State Committee for Science and Technology should organize the formulation of methods of the economic organizational analysis of the preparation, choice, and implementation of assignments of the programs by the main developers and approve the corresponding standard document.

There are quite a few successfully compiled programs in the most important directions of scientific and technical development. Thus, the scientific and technical program in the area of laser technology, which was prepared with the activity participation of managers and staff members of the Scientific Research Center for Technological Lasers of the USSR Academy of Sciences, is distinguished by the clarity of the idea, the orientation of all the intermediate goals toward the end result, the reflection of all the stages of the cycle, starting with basic research, a high level of organization of the activity of the performers, and the soundness of the technical and economic indicators. However, the practical experience of fulfilling this program showed that the uniting of various organizations within a program of even the all-union level does not always made it possible to successfully overcome interdepartmental barriers. The need of managers of many scientific and technical programs for the development of new forms of interdepartmental integration, which are conducive to the successful solution of intersectorial problems in the most

important scientific and technical directions, has arisen more and more often in recent times. Much work of the established 18 interbranch scientific technical complexes (MNTK's), including the interbranch scientific technical complex for the direction "Laser Technology," is now being launched.

Under the conditions of the extensive use of programs it is important to organize the preparation and adoption of a unified methodology of the goal program management of scientific and technical development in the country and the monitoring of its fulfillment. In several prevailing standard documents the duties of the organizations and subdivisions, which ensure the use of the advantages of goal program management, are not always specified thoroughly enough. The opinion that sectorial and functional organs lack the necessary rights for the real acceleration of scientific and technical progress, is now widespread. Moreover, new enforceable enactments are needed in addition. Their preparation should be based on a carefully thought out and well-organized experiment, after the approval of theoretically sound proposals and experience that has been verified in practice. Now such documents are often promulgated as stray acts without the preliminary checking of the basic ideas and principles. Such an approach can lead to the unjustified complication of management, which hinders the obtaining of the desired results. An economic organizational experiment on the development of versions of the mechanism of the management of all-union programs should be conducted on a competitive basis.

It is necessary to increase the role and authority of the experts, who evaluate the level and quality of the programs being formulated, and to organize regularly working groups of experts made up of the most prominent scientists and organizers of science, enlisting them in work at the stage of the selection of programs, when tallying the results of economic organizational experiments and preparing procedural materials. For this it is necessary to formulate rules of making an appraisal of the drafts of programs, which are proposed for inclusion in the state plan of the development of science and technology.

Among the sources of the deviation of the actual results of the fulfillment of the assignments of all-union programs from the planned results are the failure to support the work envisaged in them with resources, the upsetting of the deadlines of deliveries of raw materials, materials, and equipment, the ill-timed placement of production capacities into operation, the lack of specialists of the necessary type, inadequate financing, and others. The basic cause of such phenomena lies in the violation of the requirements of the priority nature of the resource supply of all-union scientific and technical programs.

However, for the improvement of the resource supply of all-union scientific and technical programs when planning capital investments for the sector "science and scientific service" it is necessary to allocate without fail limits of capital construction for all-union programs. It is also necessary to oblige the State Committee for Science and Technology to determine and then to specify for all-union programs the needs for material and technical resources, to get agreement on them with the USSR State Planning Committee, the USSR State Committee for Material and Technical Supply, and other organs, which allocate these resources, as well as to establish the procedure of their redistribution, formation, and use for the purpose of the prompt settlement of questions which arise when implementing the programs.

The causes of the nonfulfillment of the work on the programs, which were cited above, for the most part are of a subjective nature and in many respects can be eliminated in case of properly arranged planning, organizational, and procedural work.

Situations, when for the sake of a high percentage of fulfillment or in narrow departmental interests equipment and technology, which are not scientifically sound enough, are obsolete, and are inferior already at the stage of the detail and working design to the planned technical and economic level, are brought up to the stage of the development of a prototype, are encountered when implementing programs. An effective mechanism of the monitoring of the reliability of the technical and economic indicators of designs and programs has not yet been developed at the statewide level. This mechanism should make it possible to promptly identify and eliminate from the plan the plan assignments which have become ineffective.

The question of the number of all-union programs is controversial. Although the number of programs has been decreasing from five-year plan to five-year plan, the number of assignments being fulfilled has remained at approximately the same level. In practice such a decrease often reduces to the formal conversion of programs into subprograms, while the number of assignments (which determine the number of innovations) in this case is not reduced.

When determining the composition of all-union scientific and technical programs one should use as the main guidelines the demand on the development of integrated technologies and the economic impact that is anticipated from their use.

The different scale of the equipment and technology being developed (in the absence of a "common denominator," a "standard" for the innovations being developed and introduced) finds reflection in the corresponding plans of both the state and the sectorial levels. The new process of production, which is unified from the standpoint of the production purpose, consists of machines, technology, source raw materials, and materials, and has a control system, at the national economic level is frequently reflected in different sections of the state plan of the development of science and technology. These parts, which have a common purpose, due to the

imperfection of the mechanism of the planning of the development of science and technology are dispersed in plans of different levels: some are included in the national economic plan, others are included in sectorial plans. Given such "dispersal" losses of mandatory elements of integrated technology occur, as a result of which the useful properties of innovations are implemented in practice only in part and with a great delay.

There are many examples of the uncombined solution of scientific and technical problems. They have been repeatedly reported in the press. Thus, the increase of the scale of the use of new methods of boosting petroleum recovery and technologies of the extraction of condensate could have yielded a greater economic impact as compared with the achieved impact, if assignments on the introduction of advanced equipment, instruments, and control systems had been included in good time in the corresponding programs, while the use of secondary heat had been envisaged already at the stage of designing at many power plants that are being developed. Mainly technological processes are initially developed as unautomated processes.

Studies of the peculiarities of scientific and technical progress at present stage have shown that the need for the combined improvement of major components of the production cycle, when not some individual machine or element of the technological process is being replaced, but a new production processes is essentially being developed, that is, a qualitative leap is occurring, is moving into one of the first places. In integrated technologies the mode of production, the equipment and machines necessary for this, as well as the organization of labor, economic levers, and control systems of these technologies are integrally combined. Now it is recognized that the drastic acceleration of scientific and technical progress can be achieved first of all on the basis of the changeover to qualitatively new technologies of the latest generations. Here, as a rule, all the technical and economic indicators improve: product quality increases, the specific labor intensiveness and materials-output and power-output ratios decrease. At the same time the improvement of technologies of just one previously developed generation makes it possible to increase some indicators at the expense of the worsening of others.

However, the changeover to the planning and development of integrated technologies, which ensure not evolutionary, but rapid, revolutionary scientific and technical development, was dragged out in our country. The replacement and modernization of existing technologies occurred slowly. In most cases the following distribution of duties and responsibility formed in this process: sectorial scientific research institutes and design bureaus are responsible for the development and production of individual elements of integrated technologies, while the choice and interconnection of the elements into an integrated technology are carried out directly at production facilities with allowance made for the set of innovations, which was developed by the scientific research institutes and design bureaus, and their own efficiency proposals.

It is necessary that in the State Committee for Science and Technology the composition of all-union programs and their assignments would actually be formed according to the principle "from above" in conformity with the need for new technologies of the latest generations, as well as with allowance made for the socioeconomic indicators and scientific and technical level of the innovations being planned. The coordination by the main developers of the composition of the programs and their assignments with ministries and departments should be organized in a directive manner. For this the prediction of integrated technologies and the order of drafts of the solution of the most important problems on the development of such technologies on a competitive basis should be worked out procedurally and organizationally.

Within the state plans "The Development of Science and Technology" it is advisable to include all-union scientific and technical programs on the development and industrial assimilation, the extensive practical use of new integrated technologies, and the modernization of operating technologies for the purpose of saving manpower, energy, and material resources. All the assignments should be addressed and stipulate the client and developer (producer) of the integrated technologies. The volume of output (in physical and value terms and in percent), which it is proposed to produce by means of this technology, should be indicated in the assignments on their development and modernization.

The practice that formed during the 11th Five-Year Plan of managing the implementation or, as is now customary to call it, the accompanying of all-union scientific and technical programs for the most part is aimed at the monitoring of their fulfillment. In case of the planning and management of scientific and technical progress, while planning to obtain results that significantly surpass the achieved results, it is impossible to eliminate completely the elements of risk. Not to take risks means to take already beaten paths or simply to catch up with those in front.... Therefore, judicious adjustments of the assignments of the programs and the deadlines of their fulfillment with allowance made for new achievements at times are not avoidable. However, one must not confuse uncertainty in case of the solution of scientific and technical problems with organizational errors, which, as the analysis showed, are also a cause of refinements of all kinds. The observance of planning discipline and the establishment of organizational procedural order when fulfilling programs should be strictly mandatory. In those exceptional instances, when the planned technical and economic indicators, which guarantee an economic impact, are not confirmed, one should immediately find out how expedient the further continuation of the work is.

The bringing of obviously obsolete equipment and technology up to the stage of the production of a prototype in many respects is analogous to such antistate phenomena as upward distortions and deception.

The USSR Central Statistical Administration and the State Committee for Science and Technology should be charged to make urgent changes in the existing statistical reporting on the progress of the fulfillment of the assignments (stages) of all-union programs, having envisaged reporting not only by periods, but also by expenditures and the economic impact.

The development of effective forms of interaction at the intersectorial (interdepartmental) level should become an important condition of the improvement of the mechanism of "horizontal" interaction within the entire cycle of scientific and technical development. The increase of the importance of intersectorial interaction for the speeding up of the development of integrated technologies and innovations is explained by the fact that it is possible to solve successfully and in the shortest possible time the overwhelming majority of the present problems of scientific and technical progress only as a result of the concerted joint actions of tens and at times hundreds of organizations, as a rule, of different departmental subordination.

The analysis of the interaction of institutes, which are subordinate to the USSR Academy of Sciences, with sectorial organizations and industrial enterprises showed that a significant portion of the obtained results (more than 40 percent) are implemented within so-called free transfer without regard for the interests of the client or their future user and are not regulated by any enforceable enactments which stipulate mutual obligations for the cooperating parties.

Difficulties, which hinder the effective use of the scientific potential of the higher school, arise in case of the interaction of VUZ science with sectorial science and production. To overcome them both the management of higher educational institutions and the management of the ministries and departments, which are cooperating with the higher educational institutions, need to exert considerable efforts. The experience of organizing goal program management at the Moscow Institute of Petroleum and Gas imeni Academician I.M. Gubkin can serve as a positive example of the reform of the system of management of VUZ science within a large polytechnical higher educational institution. The improvement of the planning and organizational formulation and implementation of programs on a number of most important problems (new methods of the search for and prospecting of petroleum and gas deposits under difficult geological mining conditions, tertiary methods of petroleum recovery, and others) enabled the rector's office of the institute to accomplish the reorientation of faculties, chairs, and laboratories toward extensive participation in the most important programs for the sectors.

Introduction remains the weakest link in the system of intersectorial interaction. The choice of the form, which is best for the achieved state, of organizational interaction with the participants in many respects depends on the level of organization of the joint continuation of work with partners who are interested in the subsequent use of the results. The active position of the authors of scientific ideas often proves to be a decisive factor in the bringing of innovations up to the stage of the implementation of developments and their mass introduction (as a positive example it is possible to cite the example of the development of domestic complexones and the improvement of many technologies on their basis—the authors are Professor N.M. Dyatolva and Professor V.Ya. Temkina). However, it is possible to cite even more examples, when these efforts were incapable of overcoming the inertia of sectorial thinking, which in a number of cases led then to the loss of domestic priority in the extensive use of technology of new generations. The increase of the interest of enterprises and organizations in the substantiation of the need (the ordering), the development, and the obtaining of efficient equipment and technology should be a decisive stimulus which influences the positive change of this process.

It should be taken into account that the process of replacing obsolete equipment and technology with new ones requires, as a rule, the performance of additional work on the "incorporation" of innovations in operating integrated technologies, which in many cases the user enterprises themselves are now forced to do (for example, in the system of the Ministry of the Petroleum Industry, the USSR Ministry of Geology, and others). Often the development of components and equipment for integrated technologies is assigned to enterprises which perform experimental and repair work (which leads to a too high estimate of the repair work being performed). The cost of the work, the fulfillment of which is being assigned more and more often to plant science, is increasing substantially with the complication of innovations. However, sectorial science is still inadequately oriented toward integrated technologies, while the models of new machines, equipment, and technological processes, which are being developed by it, in many cases are imperfect and usually "are developed" under plant conditions.

The number of plant scientific laboratories and other similar subdivisions (for example, bureaus) has increased in recent times 1.5-fold more rapidly than the total number of sectorial scientific organizations. In several sectors laboratories and design and technological bureaus of large industrial enterprises are successfully performing functions which involve the current modernization of production, the increase of the quality of the models of new equipment, which are being produced, the designing of promising models, and so on. At times inordinately expanded management personnel are concealed, in essence, under the mask of plant laboratories and other research subdivisions. At the same time it is possible to understand the reasons for the rejection by

some leading industrial enterprises, which have developed their own plant science, of the services of sectorial scientific research institutes and design bureaus. In practice two parallel forms of sectorial science are operating at present. Therefore, it is necessary to streamline its organization. When giving support to plant science, it should be borne in mind that the basic role in sectorial science belongs to scientific production associations.

In recent times individual examples of promising forms of the integration of science and production have appeared: integrated introducing organizations (for example, engineering centers, intersectorial scientific production associations), which serve many enterprises of different sectors and departments, as well as interbranch scientific technical complexes.

The experience of their establishment and activity has still been inadequately studied, although the need for new forms of the integration of science and production is exceptionally great. For example, the common character of a number of technological processes in the oil drilling and gas industry and the territorial proximity of petroleum and gas deposits, especially within one petroleum- and gas-producing region (for example, the Western Siberian region), are a solid basis for the establishment of intersectorial scientific production associations, which are oriented toward the scientific and technical development of these sectors. Technical and technological decisions on the complete development of petroleum and gas deposits, which make it possible to decrease substantially the capital and operating expenditures on their development, could have been prepared within such scientific production associations.

Another most important factor of the improvement of the economic organizational mechanism of the management of science and scientific and technical progress is the need for the radical change of the practice of management, which has formed in this sphere.

The study of the qualitative level of the management systems of a large number of scientific research institutes confirmed experimentally the existence of a dependence between the level of perfection of the management systems and the results of the activity of these scientific research institutes. At the same time the inspections being made show that the new methods of integrated goal management, network methods, and the establishment of temporary collectives of scientists for the present are still "taking root" poorly.

The further improvement of the management of scientific and technical progress is impossible without the increase of the personal responsibility of the managers of programs and assignments for their timely and high quality fulfillment. At present the most competent people from among the management personnel of ministries and departments, who as it is are frequently overburdened with the fulfillment of their own basic duties, are usually appointed the managers of programs. As a result the programs actually remain without permanent managers.

Evidently, it is necessary to reject such a practice. The question of the appointment of managers of all-union programs should be considered at the level of the USSR Government, while that of the appointment of managers of their individual sections should be considered in the State Committee for Science and Technology. Here, in our opinion, it is necessary to free from other duties the people who have been appointed managers. The direct management of a program, which is a large set of operations, should become the immediate duty of the person, who has been given the necessary rights and has concentrated fully on the fulfillment of the assigned job.

The examined questions of the improvement of economic organizational management, of course, do not exhaust all the problems that exist in this sphere. For their solution a significant scientific methods potential has been created and positive experience in its realization has been gained. The timely and efficient use of this potential will make it possible in the shortest time to accomplish the reorganization of the management of scientific and technical development in the country, which was outlined by the Communist Party.

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Functions, Duties, Selection, Training of Scientists

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[Article by Doctor of Chemical Sciences G.V. Lisichkin and Doctor of Chemical Sciences M.G. Goldfeld under the rubric "Reflections": "Scientific Personnel: The View From the Middle Floor"]

[Text] In recent times much attention has been devoted to the problem of the stimulation of scientific creativity and the increase of the efficiency of scientific research. It is no secret that, despite the existence in our country of an enormous number of scientists—both those having academic degrees and those without them—the productivity of scientific labor remains substantially lower than in the leading foreign countries, while scientific achievements are being introduced intolerably slowly into practice. Here individual major gains do not change the situation, which as a whole should be deemed unsatisfactory. Meanwhile the possibilities of extensive growth are nearly exhausted, so that the further development of basic and applied science can be achieved only by some qualitative changes in its structure. All this applies to chemistry and the disciplines related to it, perhaps, to a greater extent than to other fields of knowledge.

The most diverse steps are being proposed to increase the level of scientific research and to speed up the practical use of its results. Thus, a number of interbranch scientific technical complexes have already been established; a new system of the certification of scientific personnel with an enlarged list of positions and a more flexible system of the remuneration of scientific labor than before is being implemented; temporary scientific collectives, which are intended for the solution of the most urgent problems, are being set up; the level of the computerization and automation of experiments is increasing (although extremely slowly); centers of the collective use of expensive and scarce instruments are being organized....

All this, of course, will contribute to progress; but one should not forget that any measures will prove to be ineffective without people who are capable of obtaining truly valuable scientific knowledge. Let us attempt to examine several questions which are connected precisely with the problem of scientific personnel, since this problem is poorly visible from the middle floor of the building of science, precisely on which the authors are; their life experience is connected mainly with university and academic chemistry and several fields of research, which are related to it.

Perhaps, one of the urgent problems of university and academic science is connected with the procedure of promoting management personnel. This problem is all the more important as in recent times the rights of managers of large scientific subdivisions have been broadened substantially, particularly in the already mentioned certification of scientific personnel. The authors are not undertaking to encompass this problem in all its complexity and diversity, but several negative trends seem quite obvious. One of them is the clearly faulty practice of the excessive combining of official and public work.

Is it possible to consider it normal when the management of not only a large scientific institute, but at times also an entire field of science, as well as chairs of universities and higher educational institutions and editorial boards of several journals is concentrated in the hands of one person, although he is as wise as Solomon, when the duties of the manager of a large number of scientific councils, committees, and societies and much more are assigned to the same person? It would seem that in connection with the rapid increase of the number of highly skilled scientists, which has been occurring in recent decades, the basis for the once inevitable combining of jobs should disappear. Indeed, there were times when there actually were not enough specialists of the highest skills (candidates and doctors of sciences); now their obvious surplus is being observed in some fields of knowledge. At the same time it is easy to note that whereas previously a number of scientific posts were held by different and truly prominent scientists and organizers of science, who each had their own broad, but entirely visible group of duties, now these posts have turned out to be united in the hands of one person.

This trend is closely connected with the problem of age limitations: often the concentration of scientific administrative responsibility builds up with the years and reaches an entirely unreasonable scale by the age when at another, substantially more modest level of responsibility it is customary not without reason to reduce the group of duties. Indeed, can a person, who is 60, or else 70, successfully cope with work in more than 50 posts? But we did not make up this number....

Under these conditions deed is replaced by form; real activity in one post or another, which could be (owing to the possibilities associated with it of influencing science, the training of personnel, publishing, and so on) very effective, turns into a false method of maintaining one's own prestige. The work here, naturally, suffers.

The phenomenon of the imaginary coauthorship of people, who earlier worked actively in science, but then turned into scientific administrators, is also connected with the indicated problem. It is hardly normal when the manager of a large scientific collective turns out annually to be the coauthor of several tens, or else hundreds of articles: it is clear to any professional that it is impossible not only to write, but even to comprehend such a number of publications. We also happened to encounter such extraordinary situations, when a manager-administrator appears as a coauthor with the real writer of a work, with whom he is not acquainted at all!

Here it is appropriate to recall that the list of works of a world famous scientist, Academician N.N. Semenov, numbers a few more than 60 titles. All these works were written either by him personally or in coauthorship with a very few close students and associates. Let us also cite the opinion of Academician A.A. Krasnovskiy: it is possible to carry out scientific supervision—that is, to perform precisely that creative function in a joint study, which alone gives the right to coauthorship—in direct contact just with three or four associates.

The mold of imaginary coauthorship, which has been imposed from above (or is cultivated from below out of sycophantic and opportunistic considerations), has the property to diffuse from the upper stories of science to all its levels—as they say, a fish rots from the head. As a result one manager or another of a scientific subdivision is frequently inclined to regard any results, which have been obtained by his associates, as his own property, regardless of his real personal contribution to the study.

The concentration of administrative power in science in a few hands, together with the decisive influence on the work of various councils, committees, commissions, editorial boards, and so on, has far-reaching consequences for the development of entire fields of knowledge. For science these consequences are, as a rule, of a negative, or else catastrophic nature. First of all, they appear in the firm establishment of the monopolistic influence of some scientific schools and directions, while a monopoly in science hinders the development of new approaches and views and objectively retards the normal advance of research. This finds expression in publishing policy, in the concentration of forces and assets in specific direction, in the formation of educational courses, and in much more. Meanwhile Academician V.I. Vernadskiy wrote: "...the entire history of science at every step shows that separate individuals were more correct in their assertions than entire corporations of scientists..., who adhere to the prevailing views."

But this, so to speak, is the strategic aspect of the problem. As to everyday practice, the concentration of a large number of posts in the hands of one person inevitably entails the weakening of the work of the corresponding organs of the management of science and scientific public life.

Indeed, a manager, who holds simultaneously a large number of posts, is physically incapable of performing efficiently all the duties assigned to him; as a result he finds himself forced to take one of two routes. The first route is that the work in the corresponding organ, which so-and-so considers secondary, in practice is curtailed: heaps of unresolved issues pile up, and if these issues are resolved, it is entirely formally, without serious comprehension and discussion. As a result things come to a standstill and the possibilities, which have been incorporated in the activity of one organ or another, in practice are not realized. The other route consists in the fact that the same so-and-so delegates his powers to other, far from always competent people, whose activity is monitored with difficulty both "from below" and "from above," being protected by the prestige of the nominal manager. The end result turns out to be the same as in the first case: the work "skids" and reduces to a formality. The lack of monitoring often has the result that pointless fussing over trifles, which has nothing in common with public interests and is aimed at satisfying the petty self-seeking aspirations of bureaucrats from science, emerges in place of real work.

The problem of age limitations exists, of course, not only at the upper floors of the building of science, but also at all its levels. This problem is closely connected with the procedure of changes of the composition of groups and laboratories and the replacement of leaders, with the involvement of young personnel in research, and with the establishment of temporary collectives for a problem in place of the now existing "perpetual" collectives.

Here it would be worth looking closely at foreign experience. A specific age limit for holding administrative posts at scientific institutions has been established in several countries. This procedure applies even to prominent researchers and does not arouse objections—apparently, because after achieving the maximum age the right to conduct research is preserved for the scientist. It is natural that only whoever has not only administrative power, but also a great creative potential can exercise such a right....

Here it is of no small importance that such a large gap between the wage and the pension, which exists in our country for high-paid scientific supervisors, does not exist in many countries. As a result retirement is regarded there as an entirely natural stage of life, which is void of drama and bitterness. Moreover, often the scientist rejoices over the opportunity to devote himself entirely to scientific work, having been freed from a large amount of administrative trouble.

All this, of course, concerns not only the scientific elite, but also rank and file scientists. Intuitively it seems that in the end for the state it is more advantageous and cheaper to increase the level of pensions for scientists than to leave on the job for long years people who have exhausted their creative potentials. For such personnel dead weight not only complicates the promotion of young and promising specialists, but also worsens appreciably the overall intellectual and psychological climate in scientific collectives. Given all the difficulties of the objective evaluation of the effectiveness of scientific labor—especially in the sphere of basic research—within a narrow scientific collective it is also most clear to everyone "who is who," and if an older colleague, who holds a higher position and accordingly has a higher salary, works without the proper scientific return, the young associate inevitably gets the idea that no much is expected of him....

Having completed the discussion on this not particularly happy theme, let us turn to the opposite side of personnel policy in science. How do young people come to science and from where?

At first glance it seems that the training of scientists is the prerogative of graduate studies. Or at least of the higher educational institution. In reality this process begins back in the secondary school: experience shows that the overwhelming majority of prominent scientists made their presence known back in the upper grades. The psychological manifestations of specific aptitudes for successful activity in a certain field—including in the field of science—can also be detected in case of a careful and qualified approach at an earlier age.

A rather well-organized system of subject contests, which is called upon to identify the most capable pupils, is in operation at the schools of our country. At present the corps of scientists, particularly chemists, includes a fair number of winners of such contests, and some managers of large scientific collectives not without reason believe that the reputation of the winner of the chemistry contest retains its significance even after graduation from a higher educational institution or graduate studies.

Nevertheless it is clear that the school has significant, still unused reserves in the increase of the effectiveness of the subject and general intellectual training of pupils. It is well known that the overall level of instruction is limited by the potentials of the least successful part of the audience. The more intense and more successful instruction is, the more alike the students are in aptitude, training, and interests. In other words, the quality of instruction can be increased substantially by the differentiation of secondary education. The first major step in this direction has already been taken: the training of specialists of the middle level on the basis of vocational and technical schools has been drastically expanded. But this step, of course, should not be the last one.

The experience of experienced educators and research psychologists shows that students of the upper grades have, as a rule, a more or less pronounced aptitude for natural science and mathematical, technical, or humanities thinking. Here only only one-tenth of the students of ordinary schools and not more than one-third of the students of the best special schools of the physics and mathematics type display a manner of thinking, which is actually suitable for scientific work. Apparently, such young people should be identified in some way already during studies.

The present system of education still levels children. The overall overloading, the orientation toward uniform success in all subjects as the criterion of diligence, which also determines, incidentally, the grade in behavior—all this not only does not fan the "spark of God" in the intellect of a child, but can also extinguish the real fire and lead a young person past his true calling.

The question of the individualized training of pupils of the upper grades became urgent long ago. Let us note that in many countries positive experience exists in this matter: in part the problem can be solved by means of specialized classes and schools, but such a system so far has not undergone proper development in our country.

Pupils themselves can far from always choose in an aware manner a specialty, on which they have the necessary data. The recommendations of teachers, which are based on lengthy observations of each adolescent, the advice of parents, and psychological tests—this is what could contribute to the proper choice of occupation. Let us note that psychological tests, which have been used abroad for a long time, in places are also being successfully used in our country.

The experiment holds a special place in chemical education. Nevertheless in recent years the tendency for practical work in secondary school to decrease has been observed. The sharp decrease of the number of reagents in school chemistry laboratories, which was undertaken out of safety considerations and is being aggravated by irregularities in supply, contributed considerably to this. At a number of schools even the minimum laboratory work, which is envisaged by the syllabus, is not being performed. Moreover, the students are being ordered (in case of an inspection by superior instances?) to fill their notebook with descriptions of experiments which were never conducted!

The tendency for experimental work on chemistry in secondary school to be reduced should be deemed absolutely mistaken. For chemistry is an especially experimental science, and it is impossible to teach it abstractly. This creates an incorrect idea about the essence of the subject and sharply reduces the interest in it. At the same time it is easy to coordinate safety requirements with the tasks of a full-fledged education not by the reduction of the number of experimental works, but by the improvement of their methods, first of all by the introduction of semimicromethods. It is also possible to raise the level of the school experiment by the use of hardware, electronic equipment, chromatography, and so on.

For enrollment in a chemical higher educational institution the school leaver should overcome the barrier of entrance examinations, which in recent times has been low. The demands on such examinations of quite clear: these are, first of all, the conformity of the content of the tests to their goals, that is, to the identification of the potentially strongest—most able, skillful, diligent, and talented—portion of the entrants; these are the maximum objectivity of the testing and the procedural validity of the assignments.

In practice the situation is often different. The system of entrance examinations, which was in effect until this year, although not able to identify the level of aptitude of school leavers, tested their knowledge more or less objectively. We would like to hope that the improvement

of this system will be aimed at the elimination of its inherent shortcomings. In reality the new admission regulations merely increased the element of chance and decreased the objectivity of the testing of knowledge. Namely: the decrease of the number of examinations and the introduction of an interview, the evaluation of which is of a more arbitrary nature than the examination evaluation, make the results of selection less specific than before.

At the same time it is quite clear that for obtaining truly objective data on an entrant the testing of his knowledge and aptitude in accordance with the results of written works is necessary. Only by means of written examinations is it possible to achieve the full identity (on the procedural level) of the assignments for all school leavers; only a written examination makes it possible to fully standardize testing; only a written examination makes it possible to eliminate the lack of objectivity of evaluations, as well as abuses. Finally, one should strive to see to it that educational psychological tests, which are aimed at the identification of the aptitudes, inclinations, and abilities of entrants, would be conducted in written form.

It is natural that we are speaking only about selection for science, since in other spheres of activity not only knowledge, ingenuity, and intellectual talent, but also qualities, which are not identifiable by any written examinations, are important.

Personnel for chemical science are trained mainly at universities, of which there are about 70 in our country. Let us attempt to look more closely at them.

The picture here turns out to be quite mixed. Approximately a fourth of these higher educational institutions are established scientific educational centers with longstanding traditions, a more or less decent instrument base, and good libraries, which are known for their scientific achievements and schools. The bulk of the others are recent oblast pedagogical institutes, that is, higher educational institutions which are not properly provided with highly skilled personnel, scientific equipment, and library collections. The universities, which have been organized in recent years "in a blank spot," are also in approximately the same situation.

In other words, all universities are not alike; the level of training of the young specialists, who have graduated from them, also turns out to be far from identical. The official "price" of the diploma of the graduates of all universities is the same, although one university graduates already established independent researchers, while another graduates researchers who are capable of performing only the functions of laboratory assistants.

People may reply to us that in our times, when the number of scientists comes to the hundreds of thousands, not only and not so much brilliant individuals as competent performers, so to speak, rank and file personnel of science are needed. Indeed, the present scientific research institute is an entire enterprise, while in chemistry there are a large number of routine operations, for the fulfillment of which a university diploma is not needed at all. Therefore, the authors share the proposal, which has been widely discussed in recent times, to reduce both the admission and the graduation of specialists on the condition of the conversion of poor students to technicians and laboratory assistants.

Does this mean that the authors are speaking for the closing of a portion of the new universities? By no means. It is necessary to clearly specify that the training of instructors of the secondary school, vocational and technical schools, and tekhnikums should become their basic goal. The university atmosphere is very beneficial for the teacher, who needs a broad outlook more than narrow specialized knowledge.

The reader, who is familiar with the real situation, should note that it also happens that way in practice: more than half of the graduates of chemistry faculties of universities are assigned to schools. The paradox consists merely in the fact that in this case no distinctions are made between universities of different levels. It turns out that the graduates of the strongest universities are being sent to secondary schools, while the vacancies of instructors of higher educational institutions and associates of scientific research institutions are being filled with casual people.

One of the characteristic features of the chemistry faculties of our universities is the fact that among the students the absolute predominance of girls is observed. This particularly applies to new higher educational institutions, where there are often only 5 boys for every 100 first year students. The authors are convinced that such a state of affairs is not conducive to the development of science.

It is characteristic that among the participants in the final (republic and all-union) rounds of the chemistry competition there are significantly fewer girls than boys, while among the winners there is simply a handful of them. Consequently, if the questions on the entrance examinations were compiled in such a way that not only formal knowledge, but also the cast of mind were tested, this along with other steps would contribute to the standardization of the student body.

In the opinion of theorists of higher education, the first 3 years of a higher educational institution should be devoted to basic education, while the last 2 years should be devoted to intensive specialization and the practical mastering of an occupation. It is advisable to graduate the students, who have not been able to master basic subjects with more than a grade of fair, as well as have not taken part in scientific work in the chairs, in which one should begin to engage starting in the 2d year, with

documents which roughly correspond in their significances to the diploma of a technician or laboratory assistant; it makes sense to train the remainder of the students more thoroughly. It is possible to assume that such a system will turn out to be more effective than the one now in effect.

The above-mentioned participation of underclassmen in scientific work should be considered an entire mandatory requirement: only in this case can the student intelligently master the educational material, only in this way is it possible to cultivate in the student a genuine interest in scientific labor. Moreover, the participation of students also contributes to the more efficient work of the scientific associates of university chairs.

When organizing new universities it should be borne in mind that the chemistry (and, perhaps, not only the chemistry) faculty can work efficiently only if it is staffed by a group of scientists who are capable of conducting research at the world level; in turn this implies the need to provide the associates if only with housing with the minimum conveniences, scientific equipment, and literature. If in the city there are already several scientific research institutes which are conducing research at the world level, then associates of these scientific research institutes should be enlisted for the training of students (here is a case when the combining of jobs is entirely justified!), while graduation projects should be performed on their basis. That, for example, is how it has been done for a long time at Novosibirsk State University and the Moscow Physical Technical Institute.

It is impossible not to say a few words about graduate studies—to date still the main institution for the training of highly skilled scientific personnel. In the opinion of the authors, graduate studies in their present form to a significant extent have become obsolete.

According to the existing procedure, a graduate student is obliged in 3 years to prepare a candidate dissertation; if the wards of some supervisor do not defend dissertations on time, he is assured numerous and quite appreciable troubles. Therefore, when selecting the theme the supervisor frequently sees to it not that the work would involve the solution of some basic problem or specific applied task, but that it would be "suitable for a dissertation," that is, perhaps, is not of particular theoretical or practical importance, but with the guarantee of completion in 3 years. While this leads not only to the unwise expenditure of forces and assets, but also to the increase of "extraneous information" owing to the publication by future candidates of articles which do not contain valuable scientific information.

People may reply to us: But how, then, is one to provide with highly skilled specialists (for in the end the graduate student is still learning the techniques of independent scientific labor) outlying scientific and educational institutions and applied institutes, at which you will not always see a professor? Apparently, it is possible to solve this problem by transferring a portion of the candidates and doctors of sciences from the largest scientific centers (Moscow, Leningrad, Kiev, Novosibirsk), where their concentration is excessively high, to the scientific institutions that are being newly organized. of course, this problem is difficult, since it requires the settlement of many organizational questions, but in the end it would be possible in precisely this way to derive a significant statewide impact.

As to graduate studies proper, it would be advisable to reduce them quantitatively, having left them only at the strongest scientific schools and having lengthened the term of instruction to 4-5 years. Here, of course, the possibility of defending dissertations should be retained for degree seekers regardless of where they completed their work.

It should be noted that it is hardly advisable to organize the system of training of specialists of the highest skills in basic science, in engineering, and in technology in an entirely uniform way, as is proposed in the plan of the reform of the higher school. The system should be much more flexible, it should take into account that the task consists in some cases in the search for and development of new directions of research, and in other cases in the solution of specific applied problems on the basis of already known scientific discoveries and developments.

In our opinion, the suggestion on the organization of the institution of doctoral studies is also erroneous. This will lead, most likely, only to the artificial increase of the number of people with diplomas of doctors of sciences—of course, with the equivalent decrease of the value of such diplomas.

There is no doubt that the improvement of the training of scientific personnel and the cardinal improvement of personnel policy are a most important factor of scientific and technical progress. The difficulty of solving this problem stems first of all from the fact that it goes beyond the competence of purely scientific departments and is, in reality, a statewide problem. We would hope that it will not be forgotten during the commenced reorganization of our entire national economy.

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Computerization of Hungarian Educational System

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[Article by Gyorgy Paris, director of the Institute for the Organization of Scientific Research and Information Science of Hungary, under the rubric "The Exchange of Experience": "The Computerization of the Hungarian System of Education"]

[Text] The rapid pace of development of science and technology, the appearance of microelectronics, and the penetration of computer technology into the most diverse spheres of life have directed attention to the importance of instruction in this area. It has become clear that the tasks facing society can be effectively accomplished in conformity with the requirements of our times only by means of computer technology and information science.

The organization of instruction in work with computer hardware, taking into account the peculiarities of the system of education and the structure of the school system of the country, will take a minimum of 5-8 years. This means that during the determination of the tasks of instruction it is necessary to have an outlook for at least 10-15 years.

In the system of Hungarian higher education such instruction was begun back in 1969. Initially it was aimed at the training of specialists in computer hardware, and since 1975 also in its use. The training of future instructors in the use of such hardware in the natural and technical sciences was begun. In 1980 a decision on the need for the extension of computer technology and information science to the entire system of education was made.

The Main Directions

The program of instruction, which was adopted in 1980, set as the goal the familiarization of broad groups of the population with the advantages of computer hardware and the methods of its efficient use. In general education in the next 10-15 years it is proposed to provide knowledge on information science and computer technology, while in higher education the improvement of instruction in information science is proposed. Moreover, the task of training the adult population, which needs knowledge on computer technology, as well as its retraining in evening and correspondence divisions, which is connected with structural changes in the economy, is being posed.

The training and advanced training of instructors and teachers, who did not previously have new knowledge, as well as who work in the sphere of higher education, are being planned. In this connection educational materials and collections of problems and experiments have been revised, methods of programmed instruction have been developed and disseminated. Hardware, starting with programmable pocket calculators and the simplest personal computers to professional personal computers and, at higher educational institutions, small, medium-size, and large computers of the Unified System, is necessary for the implementation of the outlined program in the entire system of education from general educational schools to postgraduate practice.

General Educational Schools. During the 1984/85 school year elective instruction in work with computer hardware was introduced at many schools by order of the Hungarian Ministry of Culture and Education. In conformity with the program of the dissemination of school computers (hereinafter the school program) during the 1985/86 school year experimental instruction with the increase of the number of computers was carried out in part in elective classes and in part in special circles at 1 school in 10. By the beginning of the 1986/87 school year computers had already been supplied to nearly 1,000 general educational schools (about one-third of all the schools).

The competition for the writing of programs for secondary schools was replaced by competition for GENERAL EDUCATIONAL SCHOOLS, which broadened the choice of already available software for instruction.

The System of Secondary Education. At secondary specialized educational institutions they train technicians, programmers, and systems analysts for computer hardware and specialists in information processing, at gymnasiums they train operators, while an elective course in computer technology is also being introduced.

Moreover, within the school program the teaching of the fundamentals of knowledge in this area in lessons of circles, which is being extended to all types of secondary schools, except secondary medical schools, typing courses, as well as evening and correspondence divisions of secondary schools, is being carried out.

The first series-produced personal computer in Hungary for this program arrived at schools in 1983.

In accordance with a decision of the Hungarian Ministry of Culture and Education at every secondary school of the country (gymnasiums, secondary specialized educational institutions, vocational and technical schools) special circles have begun to work. During the 1983/84 school year 1,537 circles for beginners were already operating and instruction was continued in 318 circles. The experience of such lessons showed that students and teachers will equally take part in the improvement of

educational materials on microelectronics and information science, the former passive object of instruction is thereby turning into an active part of it.

The Institute for the Organization of Scientific Research and Information Science in aid of the introduction of computer hardware in instruction announced a competition for the development of syllabuses for secondary schools. As a result of this by 30 June 1986, 20,000 of them had been sent out to schools.

During the 1985/86 school year secondary educational institutions received 1,930 computers, and in all 2,765 personal computers, of which there are 2 computers each at 56 percent of the secondary schools, 3-5 computers at 34 percent of the schools, and from 6-22 at 10 percent of the schools, by this time were at their disposal. Thus, at the end of the 1985/86 school year there was on the average 1 computer per 130 students.

At the same time about 2,400 teachers received vocational training. Staff members of universities and higher educational institutions gave assistance in conducting courses. By the end of the 1985/86 school year the State Center for Instruction Techniques and the Central Institute of Pedagogy had organized courses on the improvement of skills in the area of computer technology for 7,500 instructors.

The Institute of Pedagogy is extensively introducing instruction in work with computer hardware and its use in the teaching of other subjects. The institute is studying what changes are necessary in pedagogy and in the entire system of education in connection with the great social changes, which are due to the appearance of computers, and with their extensive use in school teaching, as well as the possibilities of the use of means and methods of computer technology in vocational training.

Since the rapid introduction of such instruction and the study of the methods of its teaching are being carried out at the same time as practical work, the need for the extensive exchange of experience and the conducting of exhibitions and conferences arose. Many Budapest and county exhibitions, at which schools could display the achieved results, were organized. Competitions in computer technology for students of secondary schools, the popularity of which is increasing, have been held annually since 1983. Thus, about 13,200 students from 340 schools submitted applications for the competition of the 1985/86 school year, while during the preceding school year only 500 students did.

The Central Committee of the Hungarian Communist Youth League with professional assistance on the part of the Johann von Neimann Society for Computer Technology set up during summer vacation camps, where children can improve their knowledge in computer technology. Similar camps are also being organized by the county organizations of this society.

The Training of Instructors

For the development of instruction in work with computer hardware and the standardization of the teaching of various disciplines at higher educational institutions at the end of 1981 the Hungarian Ministry of Culture and Education established the Committee for Instruction in Computer Technology. In the time that has passed the state of affairs with respect to each professional field has been examined and the causes of arising problems and the anticipated directions of development have been analyzed.

Students of faculties of the natural sciences of universities are familiarizing themselves with the possibilities of the computer of an older generation and by means of various applied programs are learning to use it. Program documents, which have been drawn up for scientific, statistical, and scientific and technical calculations, have been disseminated everywhere.

At the humanities faculties of universities and at higher artistic educational institutions the possibilities of computer technology are still being studied poorly. At present they are acquainting future instructors of history and philology in two subjects with the fundamentals of knowledge and procedural questions on computer technology only at the Jozsef Attila University.

At this moment study rooms, in which there are from 5 to 15 school computers, are in operation at every educational institution which is engaged in the training of instructors. One should also mention separately the introduction of the subject "technology," which is intensive additional training in computer technology.

However, thus far it has still not been possible to see to it that every student would have to an adequate degree direct access to a computer.

Instruction of the Adult Population

According to rough estimates, the population has approximately 100,000 personal computers, a large portion of which are used for games. Therefore, it is necessary to perform substantial work so that the use of computers would also get a place in the household, first of all in the form of educational, cultural, and other programs. The general training of the population, in essence, is a task of education. At many centers and houses of culture courses on computer technology have already started work. The Society for the Dissemination of Scientific Knowledge and its county organizations, which are devoting more attention to the instruction of the population, are playing a significant role in this instruction. The circles "Friends of the Computer" and "Young Programmers," for which compendiums and supplementary materials have been prepared, have been established. The society has also organized clubs for the designing of computers.

The active work of the Johann von Neimann Society for Computer Technology, which is contributing to the implementation of the program of school computers, is playing a large role in the dissemination of knowledge in this area. The initiative of the society the "microclub" movement, to which it can make available the idle resources of computers of institutions, plants, and other organizations, was begun for the organization of practical work in computer technology.

Television is also aiding instruction well. It has prepared the special programs "School Television." The press is playing a large role. Sections on computer technology have been established in the journals OTLET (IDEA) and MICRO-MAGAZINE.

An instruction package (a movie, a videotape, slides, and a book), which consists of 16 parts and serves as an introduction to the fundamentals of computer technology, has been put out jointly with the Mafilm Movie Studio.

The Tasks of the 7th Five-Year Plan

The long-range tasks of the development and dissemination of electronics and the developments, which have been completed thus far, require the extensive instruction and training of specialists in this field, since electronics is penetrating all spheres of social life. That is why it is advisable to encompass the entire system of education with instruction in information science. This will enable all of society to master the fundamentals of information science and to prepare for the use of information science and electronics in all areas of work.

At general educational schools during the 7th Five-Year Plan, first, the mastering of elementary knowledge in electronics and information science and thereby the extension of the fundamentals of the culture of information science to all of society and, second, the obtaining of the necessary knowledge, which would become the base at subsequent levels of instruction in the use of and the training of specialists in information science, should become basic. For the achievement of this it is necessary that at general educational schools the necessary procedural materials, collections of problems, compendiums, programs, educational films, and so on would be available in adequate quantity. At each school not less than two instructors should have knowledge in information science and electronics. For this about 1,400 teachers should annually undergo course training, about 700 schools should receive computers (their number at each school on the average should come to 3-10 school computers), as well as modern interfaces and peripheral devices for linking teaching aids to computers.

In the system of secondary education all students of schools during the 7th Five-Year Plan should master the fundamentals of the use of computer hardware and acquire a specialty in information science and electronics. For such a result it is necessary that the schools would have in adequate quantity and at the corresponding level the necessary procedural materials, collections of problems, compendiums, programs, films, videotapes, modern interfaces and peripheral devices for linking teaching aids to computers and devices, and so on. Moreover, it is necessary that at each school on the average 4 instructors would have knowledge in information science and electronics and there would be 18 computers, preference should be given to the schools, which train technicians, as well as have shown considerable success in instruction. Simplified computer-aided design systems, means for instruction in mechatronics, and other devices are also necessary for specialized training.

The task of higher education is the teaching of knowledge in the use of information science and electronics of the highest level, as well as the training of specialists, instructors, and teachers in this field.

At technical higher educational institutions, at the natural science and technical faculties of universities, as well as at economic and management higher educational institutions during the 7th Five-Year Plan instruction in the use of computer hardware should become universal, it will be expanded at agricultural and pedagogical higher educational institutions in the humanities faculties, at medical universities, and others.

The speeding up of the improvement of instruction programs in information science and electronics with the strengthening of the systems approach and the preparation of new modern textbooks and teaching programs are among the tasks which are connected with the training of pedagogical personnel during this period. The methods and themes for the improvement of the skills of instructors will be improved. The supply of the larger organizational units of universities, higher educational institutions, and student dormitories with personal computers will be continued. Rooms of professional personal computers, which are equipped with various peripheral devices and so on, will be established at each higher educational institution.

Thus, in conformity with the state program on electronization in December 1985 the Hungarian Council of Ministers approved the directions of instruction on this problem. On this basis the Hungarian Ministry of Culture and Education in January 1986 adopted the program of instruction on the use of electronics for the 7th Five-Year Plan. The Institute for the Organization of Scientific Research and Information Science is responsible for its fulfillment.

The accomplishment of all the posed tasks will contribute to the extensive dissemination of knowledge on the use of computer hardware and information science, which will make it possible to increase the efficiency of the solution of the scientific, technical, and economic problems which face society.

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Work in Basic Directions of CEMA Comprehensive Program

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[Article: "The Comprehensive Program of Scientific and Technical Progress: The Strategy of Acceleration"; first paragraph is EKONOMICHESKOYE SOTRUDNICHESTVO STRAN-CHLENOV SEV introduction]

[Text] Large-scale international scientific production cooperation is being implemented on the basis of the Comprehensive Program of Scientific and Technical Progress of the CEMA Member Countries to 2000. This program, which has been developed into a set of interconnected agreements and contracts, has become the basis of scientific and technical progress within CEMA and one of the leading organizational elements of the further intensification and improvement of cooperation and the development of socialist economic integration and is contributing to the extensive development of specialization and cooperation in the area of science, technology, and production and to the acceleration of the growth of foreign trade.

A Year After the Start

Vyacheslav Sychev, secretary of the Council for Mutual Economic Assistance

The interaction of the fraternal countries in the production sphere today is concentrated first of all in the priority directions and, to begin with, those which are envisaged by the Comprehensive Program of Scientific and Technical Progress (KP NTP).

The questions connected with its implementation were discussed at the 42d meeting of the Session of the Council. As was noted in the statements of the heads of governments, the cooperation of the CEMA member countries within the Comprehensive Program of Scientific and Technical Progress is aimed at the development and introduction of fundamentally new types of equipment and technology and is being carried out under the supervision of main organizations which are the coordinators for problems on the basis of direct ties between enterprises, associations, and scientific and technical institutions.

What in Practice Has Been Done During the Past Year?

Attaching great political and economic importance to the Comprehensive Program of Scientific and Technical Progress, the fraternal countries provided the necessary organizational prerequisites for its fulfillment.

What do I mean? First of all the fact that a system of the management of the implementation of the Comprehensive Program of Scientific and Technical Progress was created. It is a question of the singling out in the countries at the highest level of those responsible for the performance and coordination of work as a whole and in each priority direction.

Proposals on the tasks, rights, and duties of the main organization, the procedure of its interrelations with coperformers from the CEMA member countries and the formation of joint funds, as well as a number of other organizational and procedural documents on the support of joint activity were approved.

A number of questions, which are connected with planning, resource supply, and monitoring of the fulfillment of work, were specified and settled. Means of coordinating the assignments of the Comprehensive Program of Scientific and Technical Progress with the measures of bilateral programs of cooperation to 2000 were outlined.

Drafts of technical and economic substantiations were drawn up. The majority of detailed programs, the implementation of which was begun already in 1986, were prepared and completely agreed upon by the participating countries. Drafts of the detailed programs with the assistance of competent organs of the CEMA member countries were submitted for approval directly to the main organizations—the responsible performers of specific operations, as well as to intergovernmental commissions and international organizations.

I also want to direct attention to the fact that CEMA organs actively contributed to the conclusion of new agreements on the implementation of the assignments of the priority directions of the Comprehensive Program of Scientific and Technical Progress. Among them are the general intergovernmental agreements on the development and assimilation of new materials and the technologies of their production and processing, on the rapid development of biotechnology, and on such most important problems as flexible production systems, computer-aided design systems, lightguide means of communications, and others. Three interdepartmental agreements and two contracts, including on industrial microbiology, were signed within the CEMA Permanent Commission for Cooperation in the Chemical Industry.

As a whole, as was noted at the CEMA Session, this year in the fraternal countries about 400 completed developments on problems of the Comprehensive Program of Scientific and Technical Progress are being turned over to production.

Thus, much has been and is being done. Meanwhile the basic attention of the participants in the Session was directed first of all to unresolved questions. In particular, it was noted that much work lies ahead in the formation and improvement of a full-fledged mechanism of the management of the implementation of the Comprehensive Program of Scientific and Technical Progress, which would ensure the mobilization of the accumulated economic potential and all the available reserves. The

acceleration of the changeover to extensive scientific, technical, and production cooperation, the intensification of the mutual division of labor, and the establishment and extensive development of direct ties between scientific and economic organizations are a sign of the times.

As was indicated at the working meeting of executives of the fraternal parties of the socialist CEMA member countries, which was held in Moscow at the beginning of November 1986, the development of direct ties, the extensive use of other advanced forms of collective work—joint associations and enterprises, scientific collectives and laboratories—the improvement of CEMA activity, and the changeover to scientific, technical, and production cooperation are the main reserve of the successful fulfillment of the Comprehensive Program of Scientific and Technical Progress and on this basis of the further intensification of socialist economic integration and the accomplishment of the strategic task of the present stage—the acceleration of the socioeconomic development of the fraternal countries and the increase of the well-being of their peoples.

In Priority Direction Number One

Professor Oleg Smirnov, director of the All-Union Scientific Research Institute of Applied Automated Systems

The electronization of the national economy of the countries of the socialist community by right has become priority direction number one of the Comprehensive Program of Scientific and Technical Progress (KP NTP). Today microelectronics is nothing other than the key to the program. The shift to intensive development and to a qualitatively new socioeconomic level depends more and more precisely on its extensive use.

Our institute, which was established in 1982 in conformity with the Comprehensive Program of Scientific and Technical Progress, is the main coordinating organization for the problem "The Development of the International System of the Automated Exchange of Information of the CEMA Member Countries." Comprehensive research in the area of promising automated systems and their experimental development have become the general directions of our activity. Jointly with partners we are developing new methods, procedures, algorithms, programs, and hardware complexes on the basis of advanced computer equipment for information service and the evaluation of automated systems.

The Central Institute of Scientific and Technical Information of Bulgaria, the Electric Power Institute of Hungary, the Central Institute of Documentation and Information of the GDR, the Institute of Documentation and Information of Cuba, the Center of Scientific and Technical Information of Mongolia, the Institute of the Fundamentals of Computer Technology of Poland, and the Institute of Scientific, Technical, and Economic Information of the CSSR are among our permanent partners in the implementation of the Comprehensive Program of Scientific and Technical Progress. We are also linked with the largest data banks of many Western countries.

The fact that the cooperation of our institute with partner organizations in other fraternal countries is picking up new speed, is also characteristic of the past year. Recently a plan of the International System of the Automated Exchange of Information of the CEMA Member Countries was drafted and approved and a detailed program of cooperation to 1995 was adopted. Nine countries have already begun its implementation. Today we have the technical assignment for this system and are performing work on the changeover of our joint activity to a contractual basis.

I would single out as the main problem, which is hindering multilateral contacts in our sector, the slow settlement of the question of the special-purpose financing of the set of operations in the majority of countries which are participants in the system.

The International System of the Automated Exchange of Information will afford extensive opportunities in the immediate future. In the program of the joint work of scientists and specialists there is the stage-by-stage increase of the quality and number of services being made available to users. Along with this, undoubtedly, the economic efficiency of the resources being put into circulation will also increase.

Thus, at the first stage, which encompasses 1986-1987, the bases of the functioning and development of this system will be created and the scientific research programs in the development and use of the new information technology and its components will be made more precise. The changeover, in particular, to the industrial production and introduction of the software and hardware components of this system will be accomplished by 1990. It will be accompanied by the simultaneous significant increase of the amounts of information being exchanged between the organizations of the CEMA member countries. The substantial improvement of the technology of information activity by means of automated intelligent information processing and the development of automated intermediary systems and instruction systems is planned. At the third stage (1990-1995) the national centers of the automated exchange of information will begin to a greater and greater degree to acquire the traits of "intelligent locks" between users and information centers. They will turn into kinds of "factories" for the processing, analysis, and generalization of transient information.

The effective development of the International System of the Automated Exchange of Information is completely possible only on the basis of the coordinated efforts of the fraternal countries within the corresponding direction of the Comprehensive Program of Scientific and Technical Progress.

Robots for the 21st Century

Doctor of Technical Sciences Professor Vladimir Vasilyev, deputy general director of the Scientific Production Association for Metal-Cutting Machine Tools of the Experimental Scientific Research Institute of Metal-Cutting Machine Tools

A year ago during the 41st (extraordinary) meeting of the CEMA Session in Moscow the heads of the delegations of Bulgaria, Hungary, the Republic of Cuba, Poland, the USSR, and the CSSR signed a multilateral agreement on the establishment of the Interrobot International Scientific Production Association (MNPO). The implementation of the second priority direction of the Comprehensive Program of Scientific and Technical Progress—integrated automation—was thereby begun in practice.

As is known, here the cooperation of the countries of the socialist community is being developed first of all in such most important areas as the development and extensive introduction in the national economy of industrial robots, flexible production systems, computer-aided design systems, as well as plant technical management systems and plant management systems, instruments and automation equipment, and many other types of advanced high-performance equipment.

In implementing the Comprehensive Program, our association, which is the main organization for robotics, is striving for the most complete use of the advantages of the international socialist division of labor. This concerns the entire chain of interrelations with performers and coperformers—from joint research, the designing of new equipment, and the making of production prototypes to the organization of series production and mutual deliveries.

In the plans of cooperation of the Experimental Scientific Research Institute of Metal-Cutting Machine Tools with partners from the fraternal countries there are more than 70 urgent themes. Jointly with the Central Scientific Research Institute of Metal-Cutting Machines in Sofia and with the participation of the Bulgarian Association of Machine Building Plants (the ZMM Scientific Production Association) we developed a unique NC automatic cylindrical grinding machine. On the basis of this machine tool we are now developing a flexible production module, which will be equipped with a Soviet-made robot.

Another similar unit is already operating successfully at Soviet and Hungarian enterprises. This is a flexible production module which consists of machine tools, which were developed at the Hungarian Csepel and SZIM machine tool building enterprises and which our Soviet M-20 and M-40 robots attend. While, for example, within the Soviet-Czechoslovak Robot International Scientific Production Association one of the results of the pooling of efforts is a machine tool for the ultrasonic processing of hard materials, such as, for example, new types of metal ceramics.

Joint work is also being performed with related enterprises of Poland. The Experimental Scientific Research Institute of Metal-Cutting Machine Tools, the Warsaw Ponar-Avia FOP, and the Ponar-Ostszeszuw FUM are now forming a joint Soviet-Polish scientific research and design bureau. Its task is the development of advanced items and technologies for machine tool building, agricultural machine building, light and food industry, and other sectors.

During the first months of 1986 our association jointly with the USSR State Planning Committee analyzed the needs of the leading sectors of Soviet machine building for the importing of equipment from CEMA member countries and Yugoslavia for 1986-1990, as well as the export potentials of these states. On the basis of the analysis we drew up 24 coordinated agreements, contracts, and programs in the area of scientific and technical cooperation, the specialization and cooperation of production, as well as standardization and unification. The fulfillment of the measures, which are outlined in these documents, which have now been approved and signed by all the interested parties, will ensure the complete solution of the problems, starting with research, planning and design work, and the development of prototypes to the organization of specialized and cooperated production and mutual deliveries.

It is characteristic that about 80 percent of the themes with respect to multilateral and bilateral programs are aimed at the development of prototypes of equipment and components, which will make it possible to decrease sharply their importing from capitalist countries.

Now, when the practical work on the implementation of the Comprehensive Program of Scientific and Technical Progress is being developed, the task of the Interrobot International Scientific Production Association is to see to it that common efforts would be aimed at the development of models of promising robotics with the shortening of the time of their introduction to one-fourth to one-half. The main thing in our interaction is the focusing of the attention of all the participants in the main directions and the elimination of duplication, especially when it is a question of making up complete systems of control, adaptation, diagnosis, and pattern recognition. In other words, in those spheres which govern success in the development of equipment and technologies of new generations.

In our association it has become a law: every new model should correspond to the predicted best world standards of the year for which its production is planned. Only in this case is it possible to keep pace with the times and to see to it that practically all the basic types of products of

machine building would correspond to the world level. All the developers of new equipment in the countries of the socialist community are striving precisely for the achievement of this goal.

Atomic Energy: By the Pooling of Efforts

Doctor of Economic Sciences Armen Abagyan, director of the All-Union Scientific Research Institute for the Operation of Nuclear Electric Power Plants

The All-Union Scientific Research Institute of Nuclear Electric Power Plants (VNIIAES) is the main coordinating organization for a number of themes of the third priority direction of the Comprehensive Program of Scientific and Technical Progress. The range of problems of the work was selected in order to ensure the sharp increase of the efficiency of research in the most important directions and to gain time.

Such questions as the improvement of the organization and performance of the repair of nuclear electric power plants, the increase of their maneuverability characteristics, the development of advanced programs and technical means of the training of personnel for nuclear power engineering, and the implementation of a set of measures on the increase of the safety of nuclear electric power plants are included in the program of joint actions.

In June 1986 an understanding on the stepping up of work on the improvement of the organization and performance of the repair of nuclear electric power plants was reached between the CEMA member countries. Specialists of the All-Union Scientific Research Institute of Nuclear Electric Power Plants visited Bulgaria, Hungary, the GDR, and the CSSR, where they discussed drafts of working plans, contracts, and multilateral agreements. At the conference of representatives of the CEMA member countries, which was held in November 1986 at the All-Union Scientific Research Institute of Nuclear Electric Power Plants, it was noted that the implementation of joint developments will make it possible during the next two 5-year periods to increase substantially the efficiency and quality of repair service. In particular, the shortening of the time of the planned downtimes of the power-generating units of nuclear electric power plants for repairs by 10-12 percent, material expenditures by 8-10 percent, and supplementary expenditures on repair operations (including work on the checking of the metal of equipment and piping systems) by 15-20 percent will be achieved.

Detailed programs, which envisage the development of technical and technological documents and prototypes of machines and instruments, were formulated with respect to the other problems of the third priority direction. A wide range of joint research and development, which will enable our countries to attain a qualitatively new level of the reliable, safe, and economical operation of nuclear electric power plants, has to be performed with respect to each of them.

I will cite examples. As is known, the checking of the steam generators and the metal of the vessels of water-moderated water-cooled power reactors (VVER's) from within and the remote inspection of the internal surfaces of piping systems are important for the safe operation of nuclear electric power plants.

Considerable experience in the development and production of remote control devices, inspection devices, and ultrasonic and probe-type magnetic-field test instruments and their metrological support has been gained in the Soviet Union. A new principle of the building of simple and very rigid manipulators was developed at the All-Union Scientific Research Institute of Nuclear Electric Power Plants. On its part the Skoda enterprise (the CSSR) is a well-known developer and producer of various mechanisms, systems of their control, and means of transportation. The GDR produces advanced minicomputers. The integration of the efforts of the organization of these three countries will make it possible to develop a device which surpasses the now existing ones with respect to the basic parameters, such as speed and the amount of information obtained, simplicity and low cost, and accessibility when performing repair operations.

Experience in the production of specialized remote control units for nuclear electric power plants has also been gained at the All-Union Scientific Research Institute of Nuclear Electric Power Plants, experience in the production of transport mechanisms for the checking of piping systems has been gained at the Institute of Nuclear Electric Power Plants (the CSSR). As a result of the uniting of the efforts of specialists of our countries effective, simple, reliable, and inexpensive equipment for the remote monitoring of piping systems during the operation of nuclear electric power plants will appear.

Let us now take the system for the checking of steam generators. In the GDR subsystems of the checking of the tubing of steam generators have now been developed at the enterprises of the Kernkraft-Bau Combine (KKB) and the Nuclear Electric Power Plant Bruno Loeschner, ultrasonic equipment, which ensures the highest sensitivity when checking austenite welds, as well as television and inspection equipment have been developed at our institute, and manipulators for the checking of headers and threads and a device for remote capillary monitoring have been developed in the CSSR (the Institute of Nuclear Electric Power Plants). All these scientific potentials and their possibilities, being united, will make it possible to develop in the shortest possible time and with the minimum expenditures an integrated system of the monitoring of steam generators, which satisfies the highest requirements.

I will dwell on another problem—the existence of advanced programs and technical means of the training of personnel for atomic energy. Cooperation within CEMA will shorten the time of work and will increase the quality of new simulators. Scientists and specialists of Hungary, the GDR, the USSR, and the CSSR will be their collective developers. The system as a whole and the various models, which simulate the processes and situations that occur at nuclear electric power plants, will be developed in the USSR. All the operations within the detailed program of the Comprehensive Program of Scientific and Technical Progress have been included in the thematic plan of the All-Union Scientific Research Institute of Nuclear Electric Power Plants, and we regard them as tasks of foremost importance.

The formation of a number of joint international collectives for individual themes of the Comprehensive Program of Scientific and Technical Progress, for example, for the checking of the vessels of reactors from within, as well as for devices for the checking of steam generators, is also advisable.

Being partners in a common important cause, we are striving to eliminate the organizational barriers which are hindering effective and efficient cooperation.

The importance of our work on the implementation of the Comprehensive Program in the area of atomic energy was stressed once again at the recently held 42d meeting of the CEMA Session. It is of great political importance, demonstrating the effectiveness of scientific and technical cooperation within the socialist community.

For the Computer

Corresponding Member of the USSR Academy of Sciences Ellin Bochkarev, director of the State Scientific Research and Planning Institute of the Rare Metal Industry (Giredmet)

Within the first priority direction of the Comprehensive Program of Scientific and Technical Progress the task of producing arrays of large-scale and very large-scale integrated microcircuits, which are called the "heart" and "nerves" of the computer, has been assigned to the USSR. Modern technology is making extremely rigid demands on the purity of the silicon, on the basis of which the overwhelming majority of microcircuits are produced. Literally atoms count: the content of impurities should not exceed one atom per tens and hundreds of billions of atoms of silicon!

The joint work on their development did not begin yesterday. Back in 1971 for the purpose of uniting the efforts of the CEMA member countries the Agreement on Scientific and Technical Cooperation in the Production of High-Quality Semiconductor Materials, Rare Metals, and Their Compounds and the Increase of the Efficiency of Research Development was signed between Bulgaria, Hungary, the GDR, Poland, the USSR, and the CSSR. In 1972 Romania became a party to the agreement. The functions of coordinator were assigned to our institute, the State Scientific Research and Planning Institute of the Rare Metal Industry.

The 15 years of cooperation have made it possible to increase the technical level of joint research, to expand in the CEMA member countries the production of various types of products, and to modernize production processes. The time of fulfillment of operations was shortened. A saving of assets was achieved by reducing the import of expensive materials from capitalist countries.

The majority of completed jobs were performed at a high scientific and technical level and conform to the advanced achievements of leading world firms which are the producers of the "base" for electronic equipment. These are materials for new instruments—the foundations of electronic equipment of future generations, on the development of which the collectives, which are participating in the implementation of the Comprehensive Program of Scientific and Technical Progress, are working today. I would like to mention, for example, the technology of obtaining large-diameter silicon monocrystals by Czochralski methods, which has already been introduced in production, and crucibleless smelting. For these processes the production equipment was designed and the production of silicon monocrystals 125 and 100 millimeters in diameter was organized by joint efforts. Significant gains have also been made, for example, in improving the technology of obtaining polycrystalline silicon with a reduced content of impurities.

A number of developments were carried out at the level of inventions. The majority of them at present are being successfully used in industry of the countries of the socialist community.

Several results of this research and development, which were conducted by our institute in the area of obtaining gallium arsenide monocrystals, were turned over to the Bulgarian Institute of Nonferrous Metallurgy in Plovdiv on a contractual basis. After the introduction of the equipment for obtaining gallium arsenide monocrystals and the transfer by the Soviet party of the know-how for this process Bulgarian specialists assimilated the industrial production of monocrystals. A portion of them are being delivered to the Soviet Union.

In the middle of 1986 representatives of Bulgaria, Hungary, Poland, and the USSR reached an understanding on scientific, technical, and production cooperation on the problem "The Development of Semiconductor Materials With New Properties and of Metals and Their Compounds of High Purity With Special Physical Properties and the Development of Technologies and Equipment for Their Industrial Production." The Detailed Program of Cooperation for 1986-1990, to which the SRV, the GDR, the Republic of Cuba, Mongolia, Romania, and the CSSR also recently became parties, was prepared on this basis.

The Detailed Program consists of two sections: science-technology and production-marketing. The fulfillment in 1986-1990 of 18 themes, which are aimed at the improvement of existing materials and the development of new materials for electronic and power rectifying equipment, optoelectronics, solar energy, and other most important sectors of technology and for very large-scale and very high-speed integrated circuits, is envisaged in accordance with the first of them.

In 1986 agreements on the development of the technology and necessary equipment for obtaining monocrystalline silicon more than 100 millimeters in diameter by the method of crucibleless zone melting, gallium arsenide monocrystals 75 millimeters in diameter, and epitaxial layers of silicon 125 millimeters in diameter were approved and signed with respect to 12 themes. The improvement of the technology of obtaining polycrystalline silicon and the existing methods of the analysis of ultrapure materials and the checking of the electrophysical parameters of semiconductor materials and the development of new ones are also planned. The fulfillment of these themes has already begun.

With respect to six themes agreements will be concluded by the end of 1986.

The program of production cooperation has in view the mutual rendering of technical assistance in the organization of the production of semiconductor materials and pure metals. In all 39 scientific research and experimental design institutes and industrial enterprises of the CEMA member countries are taking part in cooperation.

Biotechnology: A New Era of Plant Growing

Doctor of Biological Sciences Professor Yuriy Altukhov, deputy director of the Institute of General Genetics imeni N.P. Vavilov of the USSR Academy of Sciences

In the Comprehensive Program of Scientific and Technical Progress the section, which is connected with the genetic engineering of plants, holds a special place. This direction, which began to be developed only a few years ago, is capable of launching a new era in plant growing. For biotechnological methods make it possible to develop new forms of agricultural plants, which are resistant to diseases and pests, drought and cold, herbicides and the salinization of soils.

We are already now witnesses to the appearance of a new generation of such structures, the introduction of which into genes can lead to the appearance in the plant cell of one new protein and a new function. For example, the introduction into the chromosomes of tobacco of the gene of one of the species of bacilli ensures the protection of the plants against harm by caterpillars and grubs. By means of genetic engineering it is planned to change the amino acid composition of the proteins of cereals in order to improve the quality of vegetable protein by increasing the proportion of irreplaceable amino acids.

The implementation of these and other ideas should lead to the increase of the efficiency of agricultural production, the optimization of the use of lands, the sharp reduction of energy expenditures per unit of agricultural output, and the substantial reduction of the level of contamination of the environment by toxic chemicals and fertilizers.

The front of this work is very great, if one takes into account the diversity of plants and the difficulty of organizing the genetic material of each individual species of plants. Suffice it to mention that the plant organism exists, develops, and multiplies by means of the interaction of not less than 10,000 different genes.

In the Soviet Union work on genetic engineering at present has been started at more than 10 large scientific research institutes. One of the leading centers is our institute, which is the main coordinating organization for this problem within the Comprehensive Program of Scientific and Technical Progress.

The institute has formulated a detailed program on the theme "The Use of New Methods of Obtaining the Initial Forms, Strains, and Hybrids of Agricultural Crops and Medicinal Plants, Which Are Resistant to Various Pathogens and Adverse Environmental Factors." In June 1986 individual assignments were submitted for approval to representatives of various institutes of the USSR and the corresponding organizations of Bulgaria, Hungary, the SRV, the Republic of Cuba, and Romania. A protocol and agreement on cooperation were signed. Plans of the exchange of specialists were outlined. Contacts were established.

A group of laboratories, which deal with the problems of the genetic engineering of plants as a unit, was established at our institute. Their task is the increase of the efficiency of the selection process. Today this problem worries the scientists of many countries. I would call unique the methods of cultivating plant cells and the new methods of genetic analysis, which have been developed at our institute. In the course of cooperation they are becoming accessible to all the participants in the joint work. Among them is the Central Institute of Genetics of Cultivated Plants (the GDR), which is cooperating especially closely with us in the identification of the genes of reserve proteins of beans and cereals. We have also established close cooperation with the Research Center in the Hungarian city of Szeged, where successful experiments on the genetic transformation of plant cells are being

conducted. Joint research is also planned with the Hungarian Institute of Agriculture in Martonvasar and with the Bulgarian Laboratory of the Genetic Engineering of Plants.

We realize how great the amount of work, which has to be performed within our detailed program, is. Therefore, the intensification of cooperation and the uniting of scientific potentials, the efforts of scientists, and their experimental skills are so important.

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Science, Production in GDR Combines

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[Article by Candidate of Economic Sciences Kurt Rudolf, the International Scientific Research Institute of Control Problems, under the rubric "Problems, Research, Solutions": "GDR Combines: The Organizational Forms of the Uniting of Science and Production"; first paragraph is EKONOMICHESKOYE SOTRUDNICHESTVO STRAN-CHLENOV SEV introduction]

[Text] Valuable experience of the increasing interconnection of science and production, the concentrated introduction of the results of the scientific and technical revolution, the improvement of the central planning and management of the national economy, and the development of the initiative of enterprises has been gained in the GDR. An advanced form of the uniform management and organization of the entire reproduction process—from research to the marketing of the finished product—has been found at combines.

The Theoretical and Methodological Bases of the Problem

A leading role in the economic strategy of the Socialist Unity Party is being assigned to the inseparable union of the achievements of the scientific and technical revolution with the advantages of socialism, moreover, at its present stage the task of uniting science and production first of all on an economic basis is being posed.

So that scientific and technical achievements would become entirely and in good time the basis of social progress, that is, so that in principle the unity of scientific, technical, economic, and social progress, which is typical of socialism, would be achieved, specific organizational and economic forms of the uniting of science and production are required at each level of maturity of productive forces and production relations. Their convergence began during the industrial revolution.

Up to the middle of the 20th century two processes, which were poorly interconnected, developed simultaneously. First, the use of scientific and technical achievements in production (new items, technologies, and methods of work), on which the economic results of the activity of economic units depend to an increasing degree. Second, the industrialization of science in connection with the use of large-scale and complex apparatus and devices and the intensification of the dependence of the quality of scientific results on the material and technical base of research.

These processes and first of all the trend toward their union have colossal technical, economic, and social consequences, such as:

—the development of sectors, which ensure the use of methods of scientific work in production and a modern material and technical base of research;

—the use of laboratory methods in production, for example, in microelectronics, pharmaceutics, and the metallurgy of ultrapure metals;

—the convergence of the nature of labor in applied science and in a number of sectors of production;

—the equalization to a certain degree of the demands on the skills of scientific and engineering personnel and highly skilled workers, and so on.

Such are the manifestations of the convergence and, to a certain degree, the merging of science with production under the conditions of the scientific and technical revolution. In essence, this process confirms the theoretical assumptions of K. Marx that science is becoming a social productive force. On the basis of the teaching of the classics of Marxism-Leninism and the generalization of the trend of development of production it is possible to draw the conclusion that the process of uniting science and production at this stage is a new level (quality) of the socialization of labor and production. "During the socialization of production, which to a decisive extent is due to the scientific and technical development of the process of production, technology, and means of production," the authors of a collective monograph emphasize, "inventive and innovative activity is also socialized. The interconnection of science with production will become a decisive factor of the improvement of productive forces and the appearance of a new scale of the social organization of production."[1]

It is also possible to arrive at a similar conclusion in case of the study of the place of science in the system of productive forces. "The place of science in the system of productive forces is characterized first of all by the fact that precisely it determines the level of the elements of the system and their efficient combination.... In the

process of the scientific and technical revolution important changes are occurring in the system of productive forces, their elements, and their interconnection. Their effectiveness depends first of all on their 'collective' development and use."[2]

Thus, science holds a decisive place in the solution of the key problems of economic strategy. Urgent production, spiritual, and cultural needs of society serve as its starting and end point of development. The analysis of the present state of affairs testifies that, in spite of a certain end in itself of scientific and technical development (of which the laws of development itself, especially of basic science, constitute the bases), the uniting of science and production also leads to the uniting of the starting and end points of their development. From such a standpoint the importance of the sphere of marketing of both the end and the starting phase increases in the specific national economic process of reproduction. Precisely this phase has an ever increasing influence on the formation of the volume and structure and the direction of development of science (first of all applied science) and on the evaluation of scientific activity. On this basis one should examine the uniting of science and production first of all from the standpoint of the sphere of marketing. This process, which K. Marx defined as an immament process of "large-scale industry," today appears in the form of the science-technology-production-marketing cycle. Moreover, basic science is more and more a component of this cycle.

In this connection the question of the organizational forms of the uniting of science and production is arising. It is possible to examine from a theoretical standpoint the various organizational forms and versions of their combination, for example: combining on the basis of a large production potential (a production economic association in the form of a scientific production association or combines); combining on the basis of a powerful scientific organization with the attachment to it of a production potential; combining around a large marketing or trade organization; the assurance of this unity by a flexible network of small and medium introducing engineering organizations and enterprises.

In the GDR since the middle of the 1970's the uniting of science and production has taken place within combines of central and, in recent times, district subordination. "There is united in the combine," Doctor of Economic Sciences G. Friedrich asserts, "what should be united from the standpoint of the national economic reproduction process: production capacities for the output of a specific assortment of items with the corresponding research and development potential, technologies, and the introduction of scientific and technical achievements into production up to its own organizations for marketing on the domestic market and for export."[3]

Such an organizational form of the uniting of science and production has two advantages. It makes it possible, on the one hand, to introduce scientific and technical results in good time and quite extensively and, on the other, to react quite rapidly to changing needs. These advantages are based on the fact that combines independently form better and more rapidly their own industrial, scientific, and technical potential in order to introduce their own developments rapidly and efficiently.

In the GDR they are devoting much attention to the optimum distribution of labor and cooperation among the individual subdivisions of the combine. The organization within the combine is subordinate to a greater and greater degree to the coordination of the phases of the innovation cycle. But the most correct organizational structure yields the full possible impact only in case of a good level of the material and technical supply of research, development, and introduction. In this connection the successful realization of the advantages of the combine form of uniting science and production depends first of all on the possibilities of rationalization, renovation, and marketing.

M. Bezer, the director of one of the leading combines of light industry of the GDR, asserts that one of the most important problems of the constant improvement of the management of combines is the fact that any measure on intracombine organization (the specification of the size of enterprises, the centralization and decentralization of the research and development potential, marketing, and so on) should conform to the trends of socialization. From this it follows that the uniting of science and production should be subordinate to the efficiency of the entire process of reproduction, combining a stable organizational framework and flexibility in the formation of the scientific, technical, and production potential. Hence the difference of the specific organizational forms at combines of the GDR.

The Formation and Structure of the Scientific and Technical Potential of Combines

As has already been noted, in the GDR the uniting of science and production involves first of all the formation and strengthening of combines. The majority of them with respect to the content of activity are production scientific combines. Since in GDR industry from 3 to 10 combines operate in sectors, sectorial institutes prove to be unnecessary. There are only individual sectorial and intersectorial institutes, for example, the Institute of Communications Electronics, as well as the Institute of Precision Mechanics and Measuring Equipment, and so on, which, as a rule, work on problems of intersectorial technical and technological development. From 80 to 95 percent of the sectorial scientific and technical potential, which comes to 60 percent of the entire scientific personnel potential of the country, is concentrated at combines. And the potential of sectorial and intersectorial scientific research institutes on the basis of economic contracts has been put to use for the solution of the problems of combines.

An important prerequisite of the efficient use of the powerful potential of combines is its proper arrangement, internal structure, and flexibility. The unified and efficient management of science and technology, which will also require the establishment of a centralized potential, as well as the potential of the enterprises of combines, ensures the accomplishment of these tasks. The more efficient use of this potential is also on the agenda.

The following basic forms of the organization of the scientific and technical potential over the unified science-technology-production-marketing cycle has developed at combines of the GDR.

1. Scientific research centers at industrial combines, which operate as independent enterprises:

—a unified scientific research enterprise of the combine;

—centralized technological centers;

—centers for the development of programs;

—"higher educational institution-industry" complexes;

—centralized enterprises for efficiency promotion.

2. Independent scientific and technical institutions, which operated on limited cost accounting:

—scientific research centers attached to the main enterprise and to the enterprises of the combine;

—centers for efficiency promotion attached to the main enterprise.

3. Dependent scientific and technical organizations:

—scientific, design, and technological units attached to the enterprise of the combine;

—research and design units for the development of means of efficiency promotion and consumer items attached to the main enterprise.

These basic organizational forms exist in different versions subject to the tasks of the combine. The general director bears personal responsibility for science and technology policy and for the pace of the updating of production before the sectorial ministry, the Ministry for Science and Technology, and the State Planning Commission. He forms and reorganizes the potential and distributes and redistributes assets. His possibilities here are limited by the standards of the formation and use of material and financial resources, as well as by the independence of the scientific and technical enterprises. Only the sectorial ministry jointly with the Ministry for Science and Technology can change this framework.

Once every 2-3 years the structure of the scientific and technical potential is analyzed, as a result a number of problems are identified. The most important of them is the assurance of the proportionality of the scientific and technical potential during its development. Behind this lies the problem of the efficient control of the proportions between:

—the centralized capacities and the capacities of the enterprise of the combine; basic, exploratory, and applied research; the development of items and technologies; the research, development, and design of pilot production and production as a whole; the potentials of science and technology as a whole and introduction in production.

It is possible to develop in good time the basic structure of the scientific, technical, and production potential of the combine and to create the material prerequisites for its flexible reorganization only on the basis of the constant analysis of the strategic development of science and technology in the sector and at the combine proper, as well as its connection with the prospect of marketing.

At the leading combines of the GDR this problem is being solved by the creation and expansion of the potential of basic and applied research. The specific measures encompass not only the reorganization of the potential of combines, but also the use (on an economic basis) of a portion of the potential of the GDR Academy of Sciences and the Ministry for University and Technical School Affairs.

Moreover, the development of technologies, as well as designing and pilot production are being stepped up.

The production of means of efficiency promotion is undergoing further qualitative development. A potential for the production of microelectronic elements and systems, which are specific to the given works, is being created at all large combines. Programs are being developed.

The experience of the majority of combines shows that as a whole centralized scientific centers attached to the main enterprise or research enterprises of the combine solve the problem of ensuring the proportionality of the scientific and technical potential during its development. At the same time the ratio between the centralization and decentralization of the scientific and technical potential depends on the specific nature of activity, that is, on the product, the territorial structure, as well as traditions. The flexible consideration of all the peculiarities of the combine while observing the general trends is a question which is best settled locally. Research shows that in the GDR the most different quantitative and qualitative ratios, which fluctuate between 25:75 and 80:20, exist between the centralized potentials and the potentials of enterprises.

Given all the diversity a general trend predominates: the potential of basic and applied research and development with multiplicative application (at the combine proper), as well as in the area of standardization and labor safety techniques is centralized and concentrated. Individual enterprises carry out technological research, the majority of development, and the production of means of efficiency promotion.

At the combines the departments (enterprises) of the production of means of efficiency promotion have justified themselves. At one-third of all the combines they have the production power of a medium-size machine building enterprise. From the standpoint of the scientific and technical development of combines the production of special equipment at them proved to be especially important. The production of means of efficiency promotion in these departments developed in the GDR in the following manner: in 1981 it increased by 21.4 percent, in 1982—by 18.0 percent, in 1983—by 23.0 percent, and in 1984—by 27.0 percent.

In the past 2 years a dependence of the production of means of efficiency promotion on the needs of the technology of both the producer and the consumer has been observed.

The experience of several combines, which created in addition to the concentrated unified potential under the main enterprise potentials under the enterprise in the form of several centers, which serve the entire combine with respect to individual questions or several enterprises with respect to a set of questions, is interesting. A typical example is the technological centers, for example, at the Textilmaschinenbau, Polygraf, and Elektrogeretewerk Sull combines. This form has especially been developed in light industry, where scientific and technical centers play a significant role.

In all it is possible to single out only one trend of further development as natural. This is the strengthening both in quantity and in quality of the phase of introduction. Experience shows that nearly two-thirds of the time for development is connected with preparation for introduction. Therefore, it is necessary to increase significantly the capacities of introduction and implementation, which would have a positive effect on the economic results of the use of developments and would make it possible to react more flexibly to the changing demand. In recent times in the GDR they have been attaching greater and greater importance to the sale and duplication of scientific and technical results, equipment, and technology. Therefore, it is possible to expect the strengthening of the "commercial sector" of the scientific and technical potential. Thus, the development of combines in the GDR is proceeding in the direction of the organizational consolidation of the science-production-marketing cycle.

The Forms of Scientific and Technical Cooperation of Combines

The specific form of the uniting of science and production at combines requires a special decision with respect to the coordination of their scientific and technical ties with other combines, especially with suppliers, with the enlistment of scientific and technical potentials outside the combines. Positive experience has already appeared in this sphere, but there are also quite a large number of unsolved problems. The main emphasis is being placed on the economic content and impact of these ties on the basis of the mutual interests and responsibility of each partner. Although such contracts on cooperation on specific developments are quite widespread, all the same the combines first of all use their own potential. The coordination of scientific and technical work in the sector (ministry) is a specific problem.

The activity of ministries is aimed at the intensification of the formulation of long-range concepts of development and is carried out in close cooperation with the management of the combines. Ministries prepare decisions on the problems of the long-range development of the sector; complex problems, the solution of which envisages a high level of interrelations with other sectors and territories; the most efficient production structure from a national economic standpoint; the proportional development of the progress of the preparation and carrying out of production; the main directions of science and technology (for example, the development of microelectronics); the long-range intensification of production (in particular, the saving of materials and energy, the use of secondary raw materials, and others).

In managing scientific and technical progress, the ministries concentrate activity on the fulfillment of the state plan on science and technology, which includes:

—tasks of the most important innovation processes in the national economy (they are established as state assignments);

—special tasks on the achievement of leading results in research and development, on standardization, and on license activity;

—obligations which follow from interstate agreements on scientific and technical cooperation (especially with CEMA member countries);

—national economic assignments on the saving of working time, energy, materials, and so on;

—assignments on the development of the research potential and the decrease of the expenditures on science and technology.

For the fulfillment of these and a number of other assignments research centers operate at times under ministries. Sectorial institutes (for example, for communications electronics, hard materials, machine tool building, and so on) operate as auxiliary organs of the ministry.

From this standpoint the experience of the Ministry for Chemical Industry is interesting. It has the largest share of commodity production and exports of the GDR. The Central Institute for Information and the Institute for Microbiology, as well as a trade organization, which serves several combines in the area of domestic and foreign trade, exist under the ministry. Since it is difficult for the ministry to coordinate the scientific and technical work and joint research of interested combines, for it does not have the necessary information and scientific and technical potential, scientific coordinating centers, which work directly at several combines, which are similar in type, have been established within it. There are included in the duties of these centers first of all:

—the organization and coordination of the participation of combines in scientific, technical, and production cooperation of the CEMA member countries;

—the coordination of research work;

—the management of the introduction and dissemination of joint developments;

—the study of the demand for basic items and technologies;

—the analysis of the development of items and technologies of the world level in accordance with the specialization of combines.

In addition to the accomplishment of these tasks the centers coordinate scientific and technical cooperation with other sectors, academies of sciences, and VUZ science. All the work of the centers is organized on the basis of economic contracts, they operate on limited cost accounting. These centers are subordinate directly to the deputy general director for science and technology of one of the combines. They form their own funds and have their own research base.

The Management of Scientific and Technical Development Within Combines

At the majority of combines along with the overall responsibility of the general director for scientific and technical work another three director positions are envisaged: for science and technology, for efficiency promotion, and for organization and computer technology.

There operate under the supervision of the director for science and technology: the technological planning division, the science and technology division, the pilot works, and the market research division. He supervises the cycle from the idea to the prototype, including the study of the demand, and along with the general director plays the main role in the formulation of the technology policy of the combine.

The director for efficiency promotion is responsible for the material supply of introduction, that is, for investment policy, for the rationalization of technical and technological processes, and, consequently, for the modernization of the material and technical base.

The information support of scientific and technical work is first of all included in the functions of the director for organization.

The information division, which at a number of combines is responsible for the purchase and sale of licenses and so on, also operates under the general director. The Bureau for Innovation and the combine departments of the Kammer der Technik Engineering Society also perform an auxiliary role.

Thus the important qualitative interrelations in the national economy at the level of combines are realized in practice and the effectiveness of the organizational forms of the uniting within them of science and production in the GDR is confirmed.

Footnotes

1. "Grundlagen der sozialistischen Wirtschaftsfuhrung," by a collective of authors under the direction of H. Koziolek, Berlin, Dietz Verlag, 1985, p 163.

2. K. Steinitz, "Produktivkraftentwicklung und umfassende Intensiveierung," EINHEIT, No 3, 1986, pp 244-245.

3. G. Friedrich, "The Combine and Enterprises of the Combine in the Process of Socialization," PROBLEMY TEORII I PRAKTIKI UPRAVLENIYA, No 3, 1983, p 11.

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Cooperation of CEMA Countries in Technical Innovation

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[Article by Candidate of Economic Sciences Vladimir Vladimirov under the rubric "The Improvement of the Mechanism of Cooperation" (USSR): "Cooperation Over the Entire Innovation Cycle"]

[Text] The strategic means of strengthening the economic might of the socialist community is scientific and technical progress on the basis of the uniting of the efforts of all the countries belonging to it with the leading role of the Soviet Union. At the present stage the Comprehensive Program of Scientific and Technical Progress of the CEMA Member Countries to 2000 (CP NTP) serves as the scientific and organizational base of this. Its significance consists in the assurance of the technological compatibility of the items being developed, which is fundamentally important for the introduction and extensive dissemination of advanced technologies, equipment, and materials.

A peculiarity of the Comprehensive Program of Scientific and Technical Progress also consists in the fact that the active participation of the CEMA member countries in its implementation affords them access to the most advanced developments of each other, and first of all to the achievements of Soviet science. When drawing up the Comprehensive Program of Scientific and Technical Progress the main principle: items, which are produced in conformity with its assignments, should not only be of a modern scientific and technical level, but also significantly surpass it, was observed. In essence, it is a question of equipment of tomorrow.

The joint development and introduction in production of the achievements of scientific and technical progress not only make it possible to decrease significantly the expenditures of each participant on the development of the latest equipment, but also make practicable its participation in this process regardless of the scale of the scientific, technical, and production potential.

The Foundation of Effective Interaction Has Been Laid

The basic task of the Comprehensive Program of Scientific and Technical Progress is to promote the uniting of the efforts of the participating countries and the pursuit by them of a coordinated science, technology, and economic policy in such decisive spheres of the development of technology as electronics, the production of automation equipment, atomic energy, the development of new types of materials, and biotechnology. Some work in this direction was also performed earlier. However, documents of a forecasting nature, which include general suggestions on cooperation, the implementation of which dragged on for an indefinite period, were often its result. In contrast to them the Comprehensive Program of Scientific and Technical Progress is a guide to action in the corresponding spheres of cooperation with specific assignments, performers, and deadlines and with an indication of the sources of the obtaining of the necessary resources. It performs the role of a strategic document, which subordinates the work on the coordination of national economic plans to the achievement of jointly set goals and lends cooperation a pronounced conceptual nature.

More than a year has passed since the adoption of the Comprehensive Program of Scientific and Technical Progress. In this time considerable work has been done on the development of the program into a set of interconnected agreements and contracts, which ensure the practical fulfillment of its assignments. The correctness of the decision to place at the center of the economic mechanism for the implementation of the Comprehensive Program of Scientific and Technical Progress main organizations, which are responsible for the assurance of cooperation over the entire reproduction cycle and the achievement of the end result, was confirmed. It is obvious that the foundation of an effective mechanism, which with some improvements or others will also function in the future, has been laid.

However, substantial shortcomings, the elimination of which involves the revision of a number of stereotype notions about the nature of the integration process within CEMA, were also identified. For the present it has not yet been possible to eliminate the gap that formed in the past between scientific and technical cooperation and production cooperation. The coordinated detailed programs of interaction of the parties in the accomplishment of the assignments of the Comprehensive Program of Scientific and Technical Progress are still poorly oriented toward the end result—the production of specific mechanical engineering products which surpass promising world models.

The institution of clients, that is, the future users of the finished product, with whom the scientific and technical level and quality of the product should be coordinated without fail and who should finance its production in accordance with a quota in the distribution of the future product, guaranteeing the filling of its share with an adequate content, for the present has not taken its place in the system of the management of the Comprehensive Program of Scientific and Technical Progress. Therefore, the understandings on the formation of the corresponding special-purpose funds still remain unrealized, the detailed degree of interest of each participant has not been revealed. That is why in a number of cases the detailed programs hang as if in mid-air and have not been formalized by economic agreements and contracts, they only make note of them, and they are slowly developing into assignments for specific scientific and production organizations.

The Comprehensive Program of Scientific and Technical Progress presumes the resourceful development of new, more comprehensive forms of the division of labor, which are based on the cooperation of the parties over the entire science-technology-production-marketing-use innovation cycle. Such integral cooperation in research and development and directly in production ensures a higher level of the internationalization of the reproduction process, which makes it possible to solve more successfully the problems of scientific and technical progress.

Here in production interrelations scientific and technical cooperation plays the leading role. Both forms of integration interaction should be regarded as a unified scientific production and organizational legal complex, as the basis of the goal program method of the organization of interrelations, and as the start of the formation of the corresponding international cooperation systems of different depth and scale.

In the Comprehensive Program of Scientific and Technical Progress the goal program method of organizing cooperation is embodied in most complete form. However, specific questions of establishing direct scientific production ties in their fundamental unity often still remain open, since they do not blend with the existing economic mechanism, which operates on both the national and the international scale.

Scientific, Technical, and Production Cooperation—A New Approach

In the past the integration mechanism of interaction was subordinate not so much to the development and use of new technologies as to the use of already existing ones. The task of organizing production cooperation in the manufacture of items, which still have to be designed and assimilated by joint efforts, is now arising. In this case the cooperation relations are formed first of all in terms of the future and are oriented toward the future output of a product, the development of the latest equipment is now becoming the main thing when organizing the international division of labor, while the joint introduction of scientific results in production is becoming the most important object of production cooperation.

Past experience shows that if scientific and technical cooperation is carried out without a close connection with production cooperation, it is a version of the exchange of information and scientific materials on secondary themes in such areas, in which the implementation of the submitted documents does not substantially affect the economic interests of the partners.

Therefore, the documents on scientific and technical cooperation from the very start should be interpreted in a broader sense, namely as agreements on scientific production cooperation in the development of the prototype of a new product, its introduction in production, and joint manufacture. The question of the interconnection of scientific and technical cooperation and production cooperation is now central in all the problems of the Comprehensive Program of Scientific and Technical Progress.

Comprehensive joint planning and the special-purpose financing of the corresponding measures over the entire cycle, which includes research and development (NIOKR) and the process of the introduction and assimilation of new equipment and its cooperated production and sale, is necessary. It is a question of organizing the process of the international division of labor in the production of a product, which is still nonexistent and will be produced on the basis of results that have not yet been obtained.

The new approach to the organization of cooperation consists here not so much in the fact that it begins with the drawing up of scientific and technical documents as in the fact that from the very start the future producers of the items being designed are enlisted in it. It is necessary to prepare the technological processes and the appropriate equipment in succession and at the same time as basic and applied operations.

The activity of the cooperating parties is based on joint planning, which encompasses the development, standardization, and unification of technical specifications, the technological preparation of production on the basis of part, assembly, and technological specialization, including the development of nonstandard technological equipment, production itself, and reciprocal deliveries of the cooperated product.

Any joint plan on the fulfillment of an assignment of the Comprehensive Program of Scientific and Technical Progress is a "minigoal" program, that is, a set of operations on the achievement of the posed goal and at the same time a tool of their organization. This program unites organizationally and legally into a unified whole scientific and technical cooperation, coordinated investment activity, the set of interconnected measures on the development of specialization and cooperation, and the coordination of marketing. It specifies the end results, the amount and sequence of intermediate operations, the performers, and the dates of completion.

At the same time the joint planning of the economic conditions of cooperation and the exchange of patentable documents, which should be coordinated with the scale of production of the cooperated product by the partners and the directions of its deliveries, should be carried out. It is advisable already at this stage to come to an agreement on the contract prices for the items of cooperation.

From the organizational legal standpoint joint planning should be regarded as the drawing up and conclusion by the partners of economic contracts, which regulate their interaction throughout the innovation cycle.

It is obvious that in case of the systems approach to the management of integrated cooperation within the Comprehensive Program of Scientific and Technical Progress each goal program should have a management organ, which has been provided with the appropriate legal rights and economic levers. Here it should be taken into account that the management of goal programs has also not yet been developed to an adequate degree in the national economies. The intersectorial structures of these programs come into some conflict with the traditional distributive sectorial methods of management and require the resolute elimination of interdepartmental barriers. And even within countries it is far from always possible to overcome this contradiction only by the strengthening of administrative levers, consequently, economic methods of the establishment of direct ties horizontally are necessary. This applies mainly to international cooperation.

Here direct ties are not simply a form of the establishment of business contacts and the attachment to each other of enterprises of different countries, which are participating in the fulfillment of the assignments of the Comprehensive Program of Scientific and Technical Progress (after the pattern of direct ties between enterprises within a country, which exchange products which are centrally allocated in advance), but an independently operating organizational economic and contractual law mechanism. Moreover, direct ties should without fail be of a cost accounting nature. This creates the conditions for the functioning of the stimulating mechanism of the development of scientific production cooperation, which is based on the material interests of the managing subjects. The interest of the partners in implementing the achieved understandings is ensured through economic contracts, which specify the specific duties and material liability of the parties and the economic conditions of their interaction.

International scientific production complexes, within which the combination of the collaboration of the cooperating parties on a bilateral and multilateral basis will be accomplished, will be formed as a result of the interconnected activity of the main organizations and their coperformers. International scientific production associations, which should set as a goal the pursuit of a unified technology policy at the corresponding works and would be capable of subordinating to the common goal the entire set of measures connected with the development of new equipment, will be the institutional form of such structures. These will no longer be advisory organs, but independent subjects of joint economic activity.

Thus, as compared with the previous methods of collaboration the entire process is being organized on a fundamentally different basis. In contrast to the traditional forms of foreign trade it is based on the joint economic activity of the immediate producers, who assume the basic responsibility for the settlement of practical questions. The provision of the necessary economic, legal, and organizational conditions for the direct scientific production interaction of the immediate performers is assigned to central management organs. On the one hand, the corresponding economic mechanism operates on the condition that the large economic units (scientific production associations, combines) in the complex have questions, which are connected with the development of new equipment, and independently settle them under the conditions of full cost accounting. On the other, it is presumed that central management organs supervise cooperation by means of economic levers, which regulate direct ties, and ensure the interest of the parties in their development. As a whole it is possible to say that success in the implementation of the Comprehensive Program of Scientific and Technical Progress in many respects will depend on the extent to which it is possible to set up direct interaction in the science-technology-production complex directly at the level of the economic unit.

It is a question not simply of the involvement of production economic units in the fulfillment of integration measures and their greater initiative, but of the establishment of a developed economic mechanism of scientific production cooperation. Various kinds of main organizations, to which a decisive role in the implementation of the Comprehensive Program of Scientific and Technical Progress is being assigned, should fully utilize this mechanism. They are responsible for the fulfillment of its specific assignments and determine their physical and material content. The main organizations act not simply as the coordinators of work, but as general contractors and order fillers and can themselves assume the role of general clients.

As was already noted above, the basic task of the main organization as a general contractor consists in the formulation of assignments on the basis of the technical requirements of the client (the drawing up of a detailed program) on the development and production of new equipment and the organization of specific operations in conformity with economic contracts being concluded by them with clients and coperforming organizations both within the country and abroad.

The Role of the Economic Contract Is Increasing

The Comprehensive Program of Scientific and Technical Progress contains more than 2,000 assignments, the fulfillment of which should ensure the solution of 93 most important problems of scientific and technical progress, which in turn will predetermine the new qualitative level of development of the economy of the fraternal countries. It is envisaged to accomplish the majority of the assignments by the international specialization and cooperation of production (MSKP). For this, as was already said, it is necessary to specify the needs of the countries for new products, the mutual volumes of deliveries, and the specific forms of production cooperation and to settle questions of the joint establishment of production capacities.

Moreover, it is necessary to jointly coordinate the economic conditions of cooperation in science and production, to establish the sources of financing of operations, and to distribute fairly the burden of material expenditures in conformity with the participation of the parties in the consumption of the final result. It is natural that all understandings should be legally formalized and the material liability of the partners for the fulfillment of the assumed obligations should be clearly specified.

Finally, and this is the main thing, it is important to ensure the intense scientific production interaction of the immediate performers of the coordinated plans. It is quite obvious that it is hardly possible to complete all this work promptly, in the shortest possible time, by traditional methods. For during the implementation of each measure of the Comprehensive Program of Scientific and Technical Progress it is important to set up specific joint works, which are a branched cooperation structure that encompasses the numerous coperformers, which operate in different, although in principle unified, planning systems and under the conditions of the exclusiveness of national state property and are subordinate in the countries to different departments and organizations.

It would be very problematic to attempt to organize the joint comprehensive planning of research and development and production cooperation in conformity with the existing plan coordination procedures, especially taking into account the need for the simultaneous coordination of the economic conditions of cooperation and the volumes of reciprocal deliveries.

It has now already become obvious that it would be an illusion to try to establish such organizational structures, which would attempt at the statewide level to manage in a centralized manner and comprehensively cooperation over the entire science-technology-production-marketing cycle. It would be hopeless to count on the establishment of such structural subdivisions in central organs, which would deal as a unit with questions of research, development, and the international specialization and cooperation of production, the planning of the production and deliveries of products, the allocation of funds and currency assets, the conclusion of contracts, and the getting of agreement on trade protocols.

At the same time it is impossible not to see that all this is a unified chain of interconnected questions, the settlement of which is now broken down among performers, is drawn out in time, requires numerous consultations, and, therefore, is ineffective. Moreover, the workers of the management staff, who objectively cannot adequately handle specific questions of scientific production cooperation and know the potentials and needs of the cooperating parties, are frequently the subjects of these decisions.

Practical experience has shown that the solution of the problem should be sought in the direction of the formation of such an economic mechanism of the implementation of the Comprehensive Program of Scientific and Technical Progress, at the center of which the performers—the main organizations for the problems—would be. They are becoming the main subjects which organize scientific production cooperation. In other words, the plans drafted by these organizations are the basic plans of the interaction of specific performers of the assignments of the Comprehensive Program of Scientific and Technical Progress, while the organizations themselves act as independent cost accounting subjects of international economic relations. It is natural that they should function on the basis of self-support [samookupayemost] and self-financing, the opportunity to use directly the credits of national and international banks should be granted to them. Of course, this does not apply to the main organizations which carry out only coordinating work.

Here the need for the detailed planning of integration measures at the national economic level, their inclusion by a separate line in the protocol on the coordination of national economic plans, and the special-purpose allocation of the corresponding resources for each individual export-import transaction disappears. In any case the decisions on scientific production cooperation should be coordinated and made not at the national economic level, but by the corresponding main organizations and their coperformers.

In such a mechanism the economic contract between the partners acts as the basic tool of the planning of cooperation and the formulation of the plans of collaboration in the fulfillment of the assignments of the Comprehensive Program of Scientific and Technical Progress and at the same time as a document, which formalizes reciprocal deliveries of cooperation items and services, that is, as an agreement-contract.

In the USSR and other CEMA member countries the main organizations have already been granted the right to independently draw up, sign, and implement economic contracts on scientific production cooperation, which also acquire the force of a commercial contract. However, the amount of performed work on an economic contractual basis for the present is still negligible, while the examples of such scientific and technical cooperation over the entire innovation cycle are for the present of an isolated nature.

The reasons for the formed situation are different, but several of them seem most important. Thus, for the present a system of joint planning activity, which takes fully into account the new role of the main organizations in cooperation, has not yet been developed; they themselves have still not always been completely formed as scientific production complexes, there is no developed currency and financial mechanism, which has the special-purpose function to serve the cooperation of the

immediate performers. These and other problems have to be solved during the implementation of the Comprehensive Program of Scientific and Technical Progress at the same time as the fulfillment of its specific assignments.

First of all joint planning activity should be subordinated to a great degree to the task of implementing the Comprehensive Program of Scientific and Technical Progress with allowance made for the fact that this is the leading unit of the extension of cooperation. Consequently, in such a case it is necessary to regard it not as the simple balancing of reciprocal deliveries by individual sectors and works, but as interaction in the key directions of technical progress by the joint development and production of new generations of systems of machines and equipment with the collective use of the production base, technological achievements, and scientific knowledge of the cooperating parties.

Greater Independence for the Main Organizations

Thus, the creation of the economic prerequisites for the successful functioning of international scientific production complexes, of which the economic activity of the main organizations and their coperformers serves as the basis, is the most important task of joint planning activity and its underlying source.

In such complexes commissions cannot be distributed administratively. The main organizations should have economic levers in order to have the opportunity to "influence" the coperformers both in the national economies and abroad, so that they would include in their plans the corresponding assignments and would bear material liability for their fulfillment.

The point is that the recommendatory nature of the decisions, which are made by some departments (organizations) for fulfillment by others, which are not administratively subordinate to them even within one national economy, hinders the development of scientific production cooperation. Therefore, the goal program method of management involves the extensive use of the principle of the extrastructural, informal supervision of the accomplishment of tasks on the basis of the mechanism of direct ties which are not limited by departmental barriers.

For this the main organizations should have monetary assets in convertible rubles, hard currency, as well as national currencies, which the client organizations make available to them. In turn they can form these assets by means of allocations of central planning and other economic organs. In case of the coordination of national economic plans it is necessary to enter these assets in the balances of payments and to envisage their "backing with goods" within the trade balances.

The new approach to the organization of cooperation presumes the further development in the CEMA member countries of the institution of main organizations. They should have a large scientific, technical, and production potential. The states grant them the right to settle independently all questions which are connected with the advancement of industry of the fraternal countries to the front line of technical progress. Their statewide functions lie in this.

In the USSR first of all interbranch scientific technical complexes (MNTK's), as well as powerful scientific production associations, which either have the corresponding potential or have the opportunity to actively develop it on the basis of the principles of contractual cooperation, play the role of main organizations. They independently plan the entire cycle of the production of new equipment in conformity with the allocated resources.

In the work of interbranch scientific technical complexes the system of informal supervision in their management, in case of which the interacting units are not on terms of direct subordination, is used. The so-called matrix system of management, in which the dual subordination of the participants in the interbranch scientific complex occurs: along the administrative organizational line to their own ministry, and operationally to the organ, which manages the complex and is the manager of the allocated resources, is the basis. Obviously, such a principle should also undergo extensive development in the international scientific production structures which are forming in connection with the implementation of the Comprehensive Program of Scientific and Technical Progress. The international scientific production association (MNPO) is the most appropriate institutional superstructure, which organizes direct ties within such a structure. It could perform the role of a general contractor, which assumes the obligation to provide the interested countries with the corresponding types of the latest equipment. The main organizations that are the coordinators for problems of the Comprehensive Program of Scientific and Technical Progress would become the nucleus of such associations, while the coperforming organizations would be dually subordinate—to national management organs and to international scientific production associations.

The activity of international scientific production associations from the very start should be oriented not only toward the meeting of the needs of the CEMA member countries for the latest products, but also toward joint appearance with the final product on the markets of third countries. This will facilitate the balancing of reciprocal deliveries of the cooperation products. International scientific production associations should become independent economic subjects which interact with suppliers and consumers within the framework of direct ties, that is, on an economic contractual (cost accounting) basis.

As is known, the normal functioning of cost accounting relations in their commodity-money form is impossible without the solution of the problem of prices, including for scientific and technical results. The establishment of a system of contractual settlement prices on the international socialist market in many respects will transform the nature of the realization on it of currency and financial relations and will facilitate the coordination (planning) of the economic conditions of cooperation and the finding of mutually acceptable solutions. It should be taken into account that the main organizations and coperforming organizations are acquiring the right to independently coordinate the economic conditions of cooperation exchange. Owing to this new features are arising in the functioning of the international socialist market, the opportunity to change the value basis of the convertible ruble by the establishment of its closer connection with the national currencies of the countries and their mutual convertibility is appearing.

The forming system of the management of international scientific production cooperation, which is connected with the implementation of the Comprehensive Program of Scientific and Technical Progress, serves as a prototype of the new mechanism of the management of cooperation, which is based on the use of economic methods and stimuli.

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Scientific Production Cooperation of CEMA Countries

18140142h Moscow EKONOMICHESKOYE SOTRUDNICHESTVO STRAN-CHLENOV SEV in Russian No 1, Jan 87 pp 72-76

[Article by Candidate of Economic Sciences Georgi Mirov, the International Institute of Economic Problems of the World Socialist System, under the rubric "The Improvement of the Mechanism of Cooperation": "Starting the Motors of Intensification"]

[Text] To achieve revolutionary changes in science, technology, and production—the CEMA member countries at the present stage have set themselves such a strategic task. Its accomplishment requires the maximum mobilization of the efforts and assets of each of them and the greatest efficiency and effectiveness of the use of the advantages of the international socialist division of labor and production. An exceptionally important role is being assigned to socialist economic integration.

So that the interaction between the fraternal countries in all areas would turn into a genuine motive force of scientific, technical, and economic progress, it is necessary to solve a number of urgent problems. They are well known and many times have been a topic of discussion in various CEMA organs and at different levels. In our opinion, it is impossible to regard as entirely satisfactory the degree of solution of these problems, with which, in particular, it is possible to group the following ones.

First, inadequate comprehensiveness and coordination in the development of cooperation and integration within CEMA. The inconsistency in the implementation of measures and the accomplishment of tasks decreases their effectiveness. The discrepancy in time between the fulfillment of scientific research work and the introduction of its results has an especially appreciable effect. It seems that it is necessary to begin the solution of any major production problem with scientific research and design development and to conclude it with the organization of specialized and cooperated works and with deliveries. For example, it is much more advisable to immediately begin jointly the development of a fundamentally new product on the basis of specialization and cooperation over the entire reproduction cycle than for each country to do this separately and to assimilate in succession the stages of research, introduction, production, and realization.

Second, it is useful to develop the specialization and cooperation of production both in machine building and in other sectors of the national economy—chemistry, metallurgy, light industry, and others. This will contribute to the harmonious growth of all production and to the use of the advantages of the international socialist division of labor for the more complete meeting of the needs of the economy.

Third, cooperation in production, science, and technology lags in development behind specialization. But it is well known that international cooperation creates more favorable conditions than specialization for the joint solution of some problems. Cooperative relations make it possible to a greater degree to mobilize all types of resources for the increase of production efficiency, to unite the interests of partners, and to intensify integration processes. Today elementary forms of cooperation, which do not ensure great efficiency—deliveries of assemblies and parts for the assembly of finished items—predominate as a whole, including machine building. It is possible to accomplish a number of difficult production, scientific, and technical tasks only by united efforts owing to the use of more advanced cooperative relations. They create the conditions for the transition to joint enterprises.

Fourth, the sectorial and intersectorial structures of production, which have formed in the fraternal countries, are a result of the extensive stage of their development. This also affected the division of labor and has now turned into a factor that is checking the growth of production cooperation. Soviet economists B. Ladygin and O. Chukanov direct attention to this. They stress: "If steps are not taken on the radical change of the very

structure of the division of labor in favor of intrasectorial specialization and cooperation, the integration process may slow down, while the role of reciprocal commodity exchange in the creation of the national income of the CEMA countries may decrease."[1] For the successful solution of this problem it is necessary to use as much as possible the advantages of the international cooperation of production and the expansion of part, assembly, and module specialization on the basis of a mutually agreed on, and in individual cases a common science, technology, and production policy, especially in case of the implementation of the priority directions of technical progress, which have been chosen by the fraternal states. Any underestimation of the importance and responsibility of decision making in the fulfillment of the measures of the Comprehensive Program of Scientific and Technical Progress of the CEMA Member Countries to 2000 will subsequently lead to difficulties in the intensification of integration.

The solution of the named problems is an urgent task, for they directly concern the universal intensification of the economy. The level of the output being produced and its quality and competitive ability on the world market depend on how quickly and reliably they are solved.

An important role in this process is being assigned to scientific production cooperation. The objective need for it is due to the necessity to bring into line the forms of the international socialist division and socialization of labor, as well as the joint accomplishment of impending tasks. This is a complex form of cooperation, which as if develops from scientific, technical, and production cooperation, which is widespread in CEMA.

In contrast to other forms of cooperation it presumes the uniting of the efforts of the countries in two areas—science and production. Each of them has its own peculiarities and laws of development, which affect integration, for example, the differences in the objects and pace of cooperation and integration and in the forms of the end results.

Scientific production cooperation is called upon to combine the peculiarities of both areas and to provide the conditions for the achievement of the posed goals over the unified science-production cycle. Now in CEMA the economic and organizational legal prerequisites for this exist. The fraternal countries not only are using at home the results obtained on the basis of mutual exchange, but more and more often jointly conduct research, introduce scientific achievements into production, and so on. Such experience of solving a number of problems by joint efforts has already been gained in science and production. At the same time scientific production cooperation should be regarded not as the simple set of its prevailing forms in science and production, but as qualitatively new relations which comprehensively encompass these spheres. Not only the assimilation of production, but first of all the development of new products and technology will be the object of cooperation. Such cooperation is aimed at the close interconnection of science and production, the solution of problems which are related for them, and the substantial shortening of the science-introduction-production cycle, which is the heart of the intensification of the economy.

Scientific production cooperation should be regarded as one of the factors, which contribute to the development of the scientific and technical revolution into a scientific production revolution and to the fusion of science with production. Only fundamentally new means of production will make it possible to introduce the achievements of the scientific and technical revolution, to fundamentally change production itself, and to speed up drastically the increase of labor productivity.

So that scientific production cooperation would promote to the maximum degree the intensification of the economy, it is insufficient only to correctly choose promising areas of research and production and to outline effective cooperative measures. It is very important to change the approach to the solution of a number of problems of integration, to change thinking, and to devise a mechanism of the development and management of this form, which is equal to it. At the same time for scientific production cooperation there is no need for the devising of a special mechanism of development and management. For a specific mechanism of the functioning and development of the international specialization and cooperation (MSKP) of science and technology, which in general has given a positive account of itself and for long years has served them, has already been formed. It is possible to use several elements of it in the development of scientific production cooperation, others should be improved or new ones should be developed. It is necessary in the mechanism to take into account the specific nature of this form of cooperation for the more complete identification of its advantages. In particular, it is necessary to improve the standard form of contracts, the conditions of supply and the distribution of expenditures on science and the output being produced, the planning of measures and their coordination with the national plan; different principles of the formation of the prices for products than in the contracts on international specialization and cooperation and so on should be proposed. The mechanism of the development and management of scientific production cooperation should aim the partners at the mastering of the highest achievements of the scientific and technical revolution for a radical change in the reproduction process.

In CEMA on a bilateral basis there have already been established the first two scientific production associations (NPO's) in machine building, which are an organizational form of scientific production cooperation and specialization. Here a higher level of long-term relations between the economic organizations of both countries is

characteristic. The associations confirm that it is possible to develop scientific production cooperation wherever experience has been gained and the necessary conditions for this exist. Scientific, technical, and production cooperation, which was constantly aimed at the joint solution of problems that interested both parties, was carried out for many years between the Krasnyy proletariy Plant (the USSR) and the Beroye Plant (Bulgaria). The close contacts between the organizations made it possible to achieve unity in the output of individual items and in reciprocal barter in component parts and assemblies. Subsequently this was the basic prerequisite of the formation of a joint association for the development and production of NC machine tools and flexible production modules for the machining of parts like "a rotational solid," which are intended for industrial robots and manipulators. Owing to such a form of interaction the material and technical base will be enlarged significantly, scientific research, planning, and design activity will be expanded, and the production volume will increase. The maximum utilization of the capacities of the new scientific production association will make it possible to decrease significantly the production cost and the power- and materials-output ratios of the product and to increase its quality, the conditions will be created for the output of items of the highest world level.

A scientific production association was organized in a similar way between the Ivanovo Production Association in the USSR and the Zavodi za Metalorezheshti Mashini Economic Trust (ZMM) in Bulgaria. Bilateral cooperation is being raised to a qualitatively new level—the material, scientific, and technical potentials are being united, efforts are being concentrated on the increase of the technical level of the output being produced and the standardization of items, which in the end leads to the increase of labor productivity.

The establishment of Soviet-Bulgarian scientific production associations is opening up broad horizons for joint scientific research, production, planning and design, and marketing activity. An attempt at unification over the entire reproduction cycle was made for the first time. The established international firms have broad rights. They will operate under common management and administration in conformity with a unified science and technology policy, a coordinated system of capital investments, and a production program. All the conditions are appearing for the solution of a number of problems, which was complicated given the existing forms of cooperation and integration. The countries are changing over more confidently to scientific production cooperation and specialization in conformity with the requirements of intensification.

On the Bulgarian side practically all production enterprises and scientific institutes, which are involved with the production of metal working equipment, are taking part in this process, while on the Soviet side 40 plants and 7 scientific research and planning and design organizations are. Such a powerful scientific production base is a solid foundation for the fulfillment of difficult tasks and the achievement of a high pace of the output of products.

In 1986 the decision was made to establish on the territory of Bulgaria a Bulgarian-Soviet enterprise for the joint production of electronic systems and their components for the automotive industry. The production of modern electronic systems for the increase of the economy of Soviet motor vehicles and their safety and comfort will be organized on the basis of existing joint developments. This enterprise on the basis of common capital investments will have its own planning and design bureau and technological bureau. At first on the available production capacities it is planned to set up the production of a pilot commercial series of motor vehicle electronics, instrumentation, and diagnostic equipment, which are intended for the Soviet automotive industry. As is evident, here the basic form of collaboration is scientific production cooperation, which was the natural result of longstanding scientific, technical, and production relations of various types.

The participation of Poland and the USSR in the development of the design and technology and in the production of a family of hydraulic cranes, the cooperation between the CSSR and the USSR in the output of a 110-ton dump truck, and so on can serve as an example of such cooperation.

Other examples of scientific production cooperation also exist in the practice of collaboration, but it is not yet possible to regard its effectiveness as satisfactory. The bilateral form, which exists to this day, is being used in machine building. A forthcoming task is multilateral international scientific production cooperation. Its possibilities and reserves for the present are still not being fully utilized. For the implementation of the priority directions of the Comprehensive Program it is extremely important to develop scientific production cooperation as extensively as possible on the basis of bilateral and multilateral agreements between the economic organizations of the CEMA member countries.

Stabe direct production, scientific, and technical ties between economic organizations, which have definite advantages are called upon to make a substantial contribution to the solution of this problem. In particular, they are conducive to the more complete use of the possibilities of the international socialist division of labor, the increase of the efficiency and flexibility of interaction, the acceleration of scientific and technical progress, and the intensification and the increase of the efficiency of production. More precise information on the conditions of production, on the plans and concepts of the further development of the production and export structures, and on the qualitative and quantitative changes of needs is ensured between economic organizations. These advantages of direct ties appear most fully in case of

international cooperation. A fundamental link exists between them. The more complex the form of cooperation is, the richer the content of the tasks being accomplished by means of direct ties. Cooperation creates the conditions for the establishment and development of direct ties, while they are conducive to the extension of cooperation and the complication of its form—their interdependence is manifested in this.

So that scientific production associations would be firmly established as an organizational form of scientific production cooperation and specialization, it is exceptionally important to develop the most effective mechanism of the management of their activity. At this moment such a mechanism for the present does not exist, since in the practice of cooperation there are no analogs. The generalization of the experience of Soviet-Bulgarian associations will be taken into account during its development. By right it is possible to regard them as the base for an experiment. The establishment of scientific production associations and the mechanism of their functioning will be the next major step on the way to the intensification of socialist integration.

Footnote

1. B. Ladygin and O. Chukanov, "The Strategy of the Intensification of Cooperation of the CEMA Countries," KOMMUNIST, 4, 1985, p 103.

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CEMA Cooperation In Medical Instrument Making

18140142g Moscow EKONOMICHESKOYE SOTRUDNICHESTVO STRAN-CHLENOV SEV in Russian No 1, Jan 87 pp 65-71

[Article by Yuriy Sinyakov, the CEMA Secretariat, under the rubric "The Comprehensive Program of Scientific and Technical Progress: The Strategy of Acceleration" (Moscow—Stara-Tura—Brno): "Cooperation in the Name of Health"; first paragraph is EKONOMICHESKOYE SOTRUDNICHESTVO STRAN-CHLENOV SEV introduction]

[Text] Having been reduced to miniature size and having overcome the cost "barrier," the modern computer continues its triumphant march. In practice no restricted areas remain for it. Industry and agriculture, science and management, culture and education, medicine and sports—there is no sphere of life, in which the microcomputer would not find itself. And everywhere there is a technical revolution, everywhere there are such results, about which previously one could only dream. It is possible to install it with equal success in a machine tool and a kitchen range, a motor vehicle and X-ray equipment.... And it gives everyone the outstanding ability to think, understand, and make decisions.

The Social Order

"We regard participation in the implementation of the assignments of the first priority direction of the Comprehensive Program of Scientific and Technical Progress as a 'social order'," says USSR State Prize Winner Doctor of Technical Sciences Professor V.A. Viktorov. "Together with partners we have to develop in the shortest time a wide assortment of the latest medical equipment. Only on its basis is it possible to improve radically service at polyclinics and hospitals of the CEMA member countries."

Since December 1985 the All-Union Scientific Research Institute of Medical Instrument Making (VNIIMP), which V.A. Viktorov directs, has been performing the functions of a main organization for one of the problems of the Comprehensive Program of Scientific and Technical Progress. It is a question of the development and production of equipment with the use of microelectronics and of the development of diverse and compatible assemblies and units. The agreement on multilateral cooperation, to which Bulgaria, Hungary, the GDR, the Republic of Cuba, Poland, Romania, the USSR, the CSSR, and Yugoslavia are parties, encompasses all stages—from the development of the scientific idea to the marketing of the finished product. The partners have come to an agreement not only to jointly conduct research and design equipment, but also to organize the international division of labor in the production of medical items.

In the world there are already more than 20,000 types of equipment of all kinds, which is used today by the physician. It would seem, you have to test, introduce, and use in the name of the good and health of people.

But life, especially the life of modern equipment, does not stand still. Its pace is rapidly speeding up in our electronic age. And what satisfies us today, tomorrow can become hopelessly obsolete and become an obstacle in the way of our knowledge of man.

"Where, in what fields of health care has it been decided to concentrate joint forces?" we ask the professor.

"Task number one is prevention," V.A. Viktorov answers. "The coordinated concept for the changeover to a dispensary system of the entire population was developed for this purpose. And, of course, in this enormous work one cannot do without laboratory and diagnostic centers, computer hardware, and modern instruments."

Together with the professor we acquaint ourselves with the complex of equipment which is used in the so-called prephysician examination. Here, speaking in the language of specialists, the processes of preparing patients for reception in the office of the physician are being automated. The capacity of the complex is 20 people an hour. During this time each of them passes from one terminal to another. The electronic equipment itself measures height, weight, arterial and intraocular pressure, the pulse rate, lung capacity, the strength of the right and left hands.... Here everything is done only with the assistance of intermediate medical personnel.

And here is the last stage of the examination—the medical history. The small "unit" is capable of asking and processing up to 500 questions.

Now everything known about the patient is immediately transmitted to the central microprocessor. In a matter of seconds it prepares the necessary data for the physician, recording all, even the slightest deviations from the norm.

"Last year," the director of the All-Union Scientific Research Institute of Medical Instrument Making reports, "was spent on drawing up documents. This year, 1987, we are beginning the production of prototypes, while next year we will begin the series production of equipment for conducting the prephysician routine examination. Bulgaria, the USSR, and the CSSR took part in its development, while at the stage of series production Hungary will join in it."

The development of electrocardiographic equipment of a new "intelligent" generation is being carried out in accordance with approximately the same arrangement and also by the joint forces of different countries. Designed for preventive treatment, it makes an express analysis: it records and interprets electrocardiograms and draws important conclusions about socially significant diseases.

There is also a precise division of forces here. Here, for example, is how it is forming in the development of the EKOD-01—an electrocardiograph with microprocessor control. The production of the display and control unit has been assigned to Hungary, the amplifier and microcomputer—to the USSR, the tape drives and power supply unit—to the CSSR. In the ability to think and make decisions and other basic indicators, including weight, the EKOD is superior to the best world models.

In all there are eight themes and eight complexes of equipment for different purposes in the program of cooperation. In addition to the named ones there is medical equipment for the preventive treatment of nervous and mental diseases, the resuscitation of newborn children, hemodialysis, and artificial ventilation.

A unified element base is at the basis of all the complexes of equipment. It is possible to assemble instruments of various types from standardized modules—all kinds of microprocessor units, design and debugging aids, auxiliary and peripheral devices.

"Moreover, not individual copies, but entire families and groups," V.A. Viktorov adds. "In order to overcome a disease more rapidly, the most advanced equipment is needed at all stages—from preventive treatment to rehabilitation."

The integrated systems approach in instrument making is the credo of the scientist and most prominent Soviet specialist in control problems, who for 10years now has been in charge of the All-Union Scientific Research Institute of Medical Instrument Making.

In the Intensive Mode

The unique calling card of the institute—a permanent exhibition—takes up the first floor of the enormous building. The entire technical arsenal of modern medicine is assembled here. You will encounter here such a lot of unique instruments and apparatus: a laser scalpel, holographic devices, means of fiber optics communications, and instruments of X-ray radioscopy of the latest types.

However, is it worth being amazed that the All-Union Scientific Research Institute of Medical Instrument Making in its field is the leading scientific center of the country? In the Soviet Union alone more than one-third of all the medical equipment is being produced in accordance with its developments. These are the fruits of the creative labor of its scientific collective, in which there are nearly 200 doctors and candidates of sciences, as well as the pilot plant, where about 1,000 engineers, designers, and workers are employed.

The patents of the All-Union Scientific Research Institute of Medical Instrument Making and the licenses for inventions are highly regarded in all corners of the Old and New World. Thus, in accordance with its design the English firm Nuclear Enterprises set up the production of an information acquisition and transmission system: from radioisotopic diagnostic devices to a computer. Together with French firms the "xenon-plurimet" system—for the radioisotopic analysis of the brain—was developed. The "xenon" device of the institute is at its basis.

Using advanced forms of socialist integration, the All-Union Scientific Research Institute of Medical Instrument Making is cooperating on a large scale and dynamically with related organizations of the fraternal countries. Last year fruitful results were achieved in collaboration with them. Among them is the Tonus-2 (with Bulgaria)—a portable device for treatment with

diadynamic currents, a pneumotachograph (with Hungary)—for the study of the mechanism of respiration, a family of endoscopic instruments (with the GDR), and a six-channel electrocardiograph (with the CSSR).

"Now our friends and colleagues have become partners in a new and important matter—we are jointly fulfilling assignments of the Comprehensive Program of Scientific and Technical Progress," V.A. Viktorov says. "These are the Institute of Medical Technology (Bulgaria), the Medicor Association (Hungary), a combine of medical and laboratory equipment and a plant of measuring instruments from the GDR, and the Cuban scientific centers ISID, IISA, and UZAEM. Poland is represented by the Falid-1 Factory of Electromedical Equipment, the TAMED Plant, and the ORMED Center for Research and Development of Medical Equipment, Romania is represented by the Association of Enterprises of Automated Equipment and the Institute of the Electrical Equipment Industry, the CSSR is represented by the Chirana Concern, and Yugoslavia is represented by the Zdravstvo Association."

"We have known each other for a long time," the professor continues. "We know the possibilities and strong and weak points of practically every collective. But today they expect more of us. In order to attain the leading levels of the Comprehensive Program of Scientific and Technical Progress, everyone needs to do a lot of work, the main thing is to put the additional reserves to use."

What are the first results of cooperation? In what forms is interaction being carried out? In the opinion of the director of the institute, scientific and engineering cooperation are proceeding successfully. The plans, schedules, and obligations of the partners are being met. For the present there are no grounds for concern.... The working drawings and other documents will be issued on time.

"However, we do not have the right to be content with what has been achieved," V.A. Viktorov notes. "Frankly speaking, the end results, the materialization of our own ideas, and the series output of the finished product worry us and, I am confident, our partners most of all.... Here is where effective, intensive levers of acceleration are needed."

In particular, a Soviet-Hungarian enterprise in Esztergom could become such a lever. It is planned to build it with the Medicor Association. According to the estimates of specialists, already this year it could go into operation, while next year it could achieve full capacity.

"What do we expect from the joint creation?" V.A. Viktorov says. "Competitive items. For it is a question of the element base—microprocessor means for all medical equipment. Hence, they should conform to the best world models.... Therefore, the most strict demands on the level of developments, on the quality of the finished products, and on the production cost will be in effect at the joint enterprise."

"The potential of Soviet science plus Hungarian technical standards in the end are a hard and strong alloy," the director of the All-Union Scientific Research Institute of Medical Instrument Making notes. He and other staff members of the institute rate highly the achievement of the Hungarian Medicor Association, the flexible nature of its production, and its flair for everything new and advanced.

In the export of medical equipment the combine of Hungary is among the 10 leading enterprises of the world. Approximately half of the deliveries go to CEMA member countries. From five-year plan to five-year plan the proportion of specialized items—what is produced in accordance with bilateral and multilateral agreements that have concluded within CEMA—is increasing in the production program of the Medicor Association. But this is a direct result of cooperation with organizations of the socialist states, including the All-Union Scientific Research Institute of Medical Instrument Making.

"The All-Union Scientific Research Institute of Medical Instrument Making is also maintaining lasting, long-standing relations with the Chirana Concern (the CSSR)," Professor V.A. Viktorov concludes our conversation. "In 1957 the Czechoslovak concern became the first partner of the Soviet institute in scientific and technical cooperation. Now, 30 years later, it is being filled with a new content, is being enriched by intensive forms.... Do you want to find out with what kinds? I advise you to visit Stara-Tura."

Stara-Tura Is the Capital of Chirana

You need not worry, Chirana is a well-known name for our readers. Many of them in one way or another are familiar with its products: tools, instruments, apparatus. Moreover, this is tens of hospitals and polyclinics, which have been built "turnkey" in Hungary, the GDR, Poland, and the USSR (nearly 40 percent of all its finished products are exported to the Soviet Union).

The headquarters of the Chirana Concern are located in the western part of Slovakia in a small and cozy city that is surrounded by hills. Nearby are the buildings of the large plant with a 50-year history and rich technical traditions, which gave its name to the concern.

"Chirana is not confined to Stara-Tura," General Director Candidate of Technical Sciences Jan Mahal explains, "add another institute, it is located in Brno, and four plants which are dispersed about the country—in Piestany, Praha-Modrany, Brno, and Nove-Mesto-na-Morave. In all there will turn out to be 12,500 people who are engaged in the development of medical equipment."

The experienced and energetic 47 year old manager, before taking charge of the Chirana Concern, passed through nearly all the stages of modern production, and he is very, very resolute. He is devoting basic attention to the scientific base, its expansion, and its strengthening with personnel. His immediate plans are to build in Kosice a scientific production institute of medical robotics and technology, in Bratislava-Petralka—a scientific production institute of medical systems, and in Brno—an engineering center.

Where is one to get so many high-class specialists? At some time, the general director is confident, the Chirana Concern's own higher educational institution will appear. But for the present he dreams of a chair, one for two faculties: the Machine Building Faculty at the Slovak Polytechnical Institute and the Medical Faculty at the J. Komensky University in Bratislava. And let machine builders study medicine, while future physicians study electronics. On the initiative of the Chirana Concern scientists have already begun the formulation of an entirely new intersectorial syllabus.

Jan Mahal, who is in charge of the Chirana Concern for only the second year, believes: the questions of the scientific base and personnel are primary. This is a vital necessity, a tribute to the times and the requirements of the scientific and technical revolution.

"Under these conditions," he continues, "the level of cooperation of the socialist states, which was achieved in past years, also cannot satisfy us.... Yes, our relations with partners were diverse, but, alas, were of an optional, ineffective nature. Even very important joint development was carried out too slowly. Being slow, it did not live up to the expectations of consumers. But this is millions of people, who live in different corners of the socialist community and need our products. Can we today, when our countries have embarked on the path of comprehensive intensification, hold aloof from the accomplishment of the main task? We engineers, scientists, and workers of the leading enterprises are capable of doing more, of introducing advanced innovations more rapidly, of equipping institutions of medicine more rapidly and with the latest equipment, and of carrying out mutually advantageous cooperation more rapidly and more effectively. The Chirana Concern, as you know, is participating in the accomplishment of the assignments of the Comprehensive Program of Scientific and Technical Progress, while in the foreseeable future—I am stating this with complete frankness—can increase its contribution significantly."

How do the further prospects of cooperation within the Comprehensive Program of Scientific and Technical Progress appear to the general director?

Jan Mahal does not hide it: the basic hopes are being placed on intensive forms. Here there are the development of direct ties, the establishment of joint enterprises and works, and the formation of international design bureaus and scientific centers.

Several agreements on the establishment of direct ties with organizations of the USSR, he reports, have already been prepared. The relations with the All-Union Scientific Research Institute of Medical Instrument Making—the main organization for the problem of the Comprehensive Program of Scientific and Technical Progress—are being changed over to a contractual basis. In 1986 direct production, scientific, and technical ties were established with the Moscow and Aktyubinsk plants, which produce X-ray equipment, and with the Volgograd plant of medical equipment.

While here is an example of the new form of cooperation in the history of the two countries. The Chirana Concern jointly with the USSR Ministry of the Electrical Equipment Industry is beginning the organization of the M-Tomograf International Association for the joint development, production on a cooperative basis, and marketing, including in third countries, of magnetic computer tomographs. It is presumed that the economic activity of the association will be based on the principle of the complete balance of cooperative accounts. The parties will establish a joint board of directors, joint scientific research, planning and design, and technological bureaus in Bratislava, and a joint marketing subdivision.

It is proposed to locate the assembly of the magnetic tomographs in Bratislava. The MG-2500 tomograph of Soviet design has been chosen as the base model for joint development and production.

At the end of last year another international collective: a Soviet-Czechoslovak design bureau, which is developing equipment for hemodialysis, began operating at the scientific center of the Chirana Concern (Brno).

Brno, the Beginning of the Biography

The set of equipment, which has received the name "artificial kidney," is quite well known in medical practice. It is used not only in case of renal deficiency, but also for immediate aid in case of acute poisonings, burns, and infections. Taking into account the effectiveness of the method and the new areas of its use, scientists of many countries believe that in the next few years the need for hemodialysis instruments will steadily increase.

The possibilities of the method and of the improvement of its equipment are far from exhausted. For example, the system of the acquisition and processing of the necessary information remains complex, while the very process of dialysis remains an expensive procedure. Much attention is being devoted to the appearance of the equipment. Its design is called upon to decrease the traumatizing effect of the hardware on the state of mind of the patient.

In short, an "ideal" artificial kidney so far has not been developed. But the desire for it exists, and a search is being made in many laboratories, including of socialist states.

Thus emerged the idea of uniting the efforts of Soviet and Czechoslovak scientists. Especially as the tasks facing them on the development of an electronic system, which ensures the functioning of an artificial kidney, are connected with the problems of the first priority direction of the Comprehensive Program of Scientific and Technical Progress.

Today no one can establish precisely who proposed to establish for this purpose an international design bureau. Besides, this is not important. The specialists, who became members of the Soviet-Czechoslovak collective, have known each other for more than a year, have maintained for a long time business and comradely contacts, and have constantly exchanged scientific news.

And here is the first working meeting in Brno. Managers of the joint design bureau tell about the significance of the new form of cooperation and about the goals of the work of the international collective.

Candidate of Technical Sciences A.I. Khaytlin, chief of a laboratory of the All-Union Scientific Research Institute of Medical Instrument Making (Moscow):

"Yes, indeed, this is the first business trip of Soviet specialists to Brno as full members of the international collective. However, our joint activities began not today. We started it immediately after we formulated a common view, a coordinated stand on the problem being studied. Of course, the contacts in Brno will be useful for both sides. We have something to say to each other and something to learn. Then the Czechoslovak colleagues will come to Moscow. In the future we will regularly consult with each other both in the CSSR and in the USSR. However, another thing is more important—the joint work is of a continuous nature: it does not end on the day of our departure from Brno and does not resume when the specialists of the Chirana Concern arrive in Moscow. It is constantly being carried out in conformity with the collective plans and common intentions. And, it seems, the main reason for success is incorporated in this."

Jiri Villman, chief of a laboratory of the scientific research institute of the Chirana Concern in Brno:

"During the joint work it is necessary not only to achieve scientific and technical gains, but also to reveal the advantages of the new form of cooperation. We have to learn to create in close contact and to find mutually acceptable solutions, while rejecting customary stereotypes in the name of the good of the common cause. We are firmly convinced that, by relying on the assistance and support of each other, we will be able to cover honorably the entire path—from the jointly formulated idea to the development of a prototype, which satisfies the highest demands of the scientific and technical revolution. We also hope that the fruitful scientific and technical cooperation, which we have begun, will receive subsequent continuation in production cooperation, moreover, not only of the USSR and the CSSR, but also of the other CEMA member countries, and will be of unquestionable benefit to their peoples."

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Trends of Development of Electronization in CEMA Countries

18140142e Moscow EKONOMICHESKOYE SOTRUDNICHESTVO STRAN-CHLENOV SEV in Russian No 1, Jan 87 pp 52-57

[Article by Candidate of Technical Sciences Boris Senyaninov, acting chief of a main administration of the USSR State Committee for Science and Technology, and Doctor of Technical Sciences Dmitriy Chereshkin, chief of a laboratory of the All-Union Scientific Research Institute of Systems Research of the USSR Academy of Sciences, under the rubric "The Comprehensive Program of Scientific and Technical Progress: The Strategy of Acceleration": "The First Priority Direction: A Look to the 21st Century"; first paragraph is EKONOMICHESKOYE SOTRUDNICHESTVO STRAN-CHLENOV SEV introduction]

[Text] In accomplishing the assignments of the Comprehensive Program of Scientific and Technical Progress, which is intended for the period to the end of the present century, specialists are also attempting to get a glimpse of the more distant future. The authors of the article being offered examine several trends of the development of electronization at the beginning of the next millenium.

As one of the most promising directions of scientific and technical progress the electronization of the national economy is called upon to ensure the implementation of the strategic policy, which was developed by the Communist and Workers Parties of the CEMA member countries, of the acceleration of their socioeconomic development. By electronization there are understood the development, production, and large-scale use of microelectronics, computer hardware (SVT), information science, and telecommunications in the basic spheres of social activity (production, management, science, education, service, and so on), as well as in daily life. It makes it possible both to improve existing technological processes and to develop new ones, to automate planning, design, and scientific research work, to increase the degree of information support of management decisions, to expand and to improve the quality of the information service of the population, and as a whole to raise the economy of the entire socialist community to a new level.

The fulfillment of such a task requires the consideration of a large number of scientific, economic, organizational, and technical problems, the allocation of significant capital, the establishment of modern works, and the enlistment of skilled personnel. In order to evaluate the difficulty of the arising problems and the means of their solution, it is necessary to give a brief prediction of the development of a number of the integral components of electronization, namely electronics, computer hardware, information science, and telecommunications, and their use after 2000. Domestic and foreign research in various fields of science and technology can serve as the basis of such a prediction.

Three factors will probably have the greatest influence on the further progress of electronization. First, the development of microelectronics, optoelectronics, and bioelectronics, which will ensure the development of the element base, the constant increase of the quality, and the broadening of the functional possibilities of all technical components; second, the constant expansion of the areas of its application, which will cause in turn the increase of the demands of users on the functional possibilities of hardware; third, the development of information science, which contributes to the appearance of new and the improvement of existing methods of the acquisition, storage, processing, and transmission of information—in essence, new technologies, which will make it possible to use the means of electronization effectively and most conveniently for man.

The Use of Computer Hardware: The Basic Trends

At the present stage it is still quite difficult to foresee the role of each of these factors. Today it seems advisable to us to examine only the basic trends in the use of means of electronization. Which of them is it possible to expect in the next century?

First of all this is the development of the information and computing infrastructure (IVI) of the national economy, which encompasses practically all aspects of social life (science, production, management, daily life) and is capable of meeting the needs of society for information and computing services. Such an infrastructure will ensure the large-scale use of computer hardware for the making of scientific calculations and the automation and management of industry, the information service of the population, and the accomplishment of tasks of the nonproduction sphere (trade, health care, recreation, education, and so forth) and personal service. It is being formed on the basis of the extensive use of computer hardware, which interacts with communications channels and information transmission facilities.

The following forming and interconnected components are included in the information and computing infrastructure:

—information processing centers of various types, which use computers of different kinds—from supercomputers, which are intended for collective use, to personal computers, which serve the individual user;

—centers of the acquisition and storage of large amounts of information, which are being formed on the basis of general-purpose and specialized automated databases (for example, on demography, minerals, raw materials, and so forth), as well as automated knowledge bases (on individual basic scientific disciplines);

—communications channels, which transmit digital information with high speeds and interconnect message switching centers, which are located in the centers of regions, as well as communications channels, which provide an outlet of each subscriber of the information and computing infrastructure to the corresponding message switching center;

—message switching centers, which have the high-speed distribution of information between any information processing centers.

The information and computing infrastructure is called upon to unite all the presently dissociated means of electronization into a system, which is oriented toward the increase of the standard of living of society. Here all the means of electronization, no matter where they are and no matter what role they perform (the automation of equipment and planning and design operations, scientific calculations, the information support and evaluation of decisions that are being made, and so on), will be interconnected and will be able to ensure in their aggregate the accomplishment of the tasks which have been posed for socialist society.

The information and computing infrastructure will make it possible to complete the transition to the "paperless technology" of information processing, particularly by means of electronic mail, teleconferences, the facsimile transmission of text, and so on. Such an infrastructure will provide prompt access to centralized data banks and knowledge bases to everyone working in the sphere of information processing, as well as the necessary level of the information service of the population.

Taking into account the constant progress of electronics and information science and the expansion of the functional possibilities of computer hardware and systems of communications and information transmission, the information and computing infrastructure can be developed by 2000. At the beginning of the next century it should begin to operate efficiently.

The second trend—the intellectualization and personalization of information processing facilities—will require the enlistment of a larger and larger number of people in the processes of information processing and the

changeover to the direct interaction with computers of any, even an untrained person, who wishes by means of computer hardware to solve the practical problems facing him.

The intellectualization of computers is the ability to find the optimum version of the solution of any problem posed by the user in the form which would not contradict its logic. A high level of it can be achieved owing to the development of new, higher speed computers and programs (on the basis of the principles and assumptions of the theory of artificial intelligence), by means of direct man-computer contact (in natural language), the extensive use of knowledge bases, as well as the introduction of so-called expert systems, which help man in the determination of the solutions of one difficult problem or another and in their evaluation and choice.

The term "the personalization of information processing facilities" should be understood significantly more profoundly than the possibility of working at a personal computer. It is a question of the adaptation of the information and computing system (IVS), which is formed on the basis of any computer, to the individual requirements of the given user, differentiating his problem and accordingly the information and computing system, which was "developed" by him, from other users who work with the same system, but for other purposes. In this case every user has the opportunity to "interact" with the system which is most convenient for the solution of his problems. It is unquestionable that personal computers, and more precisely speaking information and computing systems based on such computers, are one of the powerful means of realizing the principle of personalization.

It is presumed that after 2000 their functional possibilities will become so broad that they will be able to ensure intellectual information processing and adaptation to any requirements of the user.

The third trend concerns the sphere of social life and daily life. Electronization will be introduced extensively both for the dissemination of current information on occurring events and for the obtaining of necessary information (for example, on questions of history, philosophy, jurisprudence, literature, and art). Everyone who wants to will be able to instantaneously make inquiries about a commodity that interests him, order a plane ticket, a room at a hotel, and so on. Owing to the constant decrease of the cost of means of electronization, the expansion of their functional possibilities, and the development of new information technologies the comfort of our daily life will increase drastically.

Finally, in practice another trend is appearing clearly already today—the changeover to the highest degree of the automation of production processes, management, and planning and design activity on the basis of the large-scale use of means of electronization. In the future (beyond 2000) this will lead to the development of interconnected, rapidly readjustable automated works, which are controlled by automated control systems, to the change of the role of man in the production process, to the freeing of him from the fulfillment of routine operations, and to truly creative labor.

It is quite obvious that, being developed in combination, the named trends will enable the socialist community to attain a qualitatively higher level of social production. They, undoubtedly, will also have an influence on the forming of man of the new, socialist formation, high civic duty, and social thinking, who consciously creates and consumes social values.

The Set of Problems

The realization of these trends will require the solution of a number of difficult social, economic, organizational, and technical problems. For example, the establishment of the information and computing infrastructure involves organizational restructuring, while the changeover to automated flexible works involves the training and replacement of personnel, and so on. Let us examine just the technical aspects of the development of means of electronization, having arbitrarily singled out the following problems:

—the development of a new generation of computer hardware (the basic component of electronization), which will ensure the efficient use of its functional possibilities and high performance, reliability, and maintainability and will make it possible to implement the most promising architectures of computers and methods of information processing (for example, a parallel and pipeline flow of data and computations) and to change over to the production of peripheral equipment (interface devices) of the man-computer type (with direct interaction) and to the storage of very large amounts of information (with the quickest possible access to it). It is possible to expect "technological breakthroughs" in the development of computer hardware of a new type, whose basic characteristics will be on the order of a hundredfold greater than present computer hardware, in 1995-2005;

—the development of a new and the improvement of the existing element base of means of electronization, the establishment of a new technological and industrial basis of the production of promising components for computers, peripheral devices, and data transmission systems;

—the preparation of software for the rapid development of dependable and reliable programs and the changeover to the automation of programming as a process. Here it is also possible to expect technological improvements;

—the formulation of theoretical principles, which regard electronization as the development of a complex hierarchic system which functions within the national economy; the specification of the conditions for the integration of all the components into a unified system with the

assurance of its high reliability, self-organization, and rapid adaptation to changing external conditions; the ascertaining of the social role of electronization in society and the consequences of its large-scale use;

—the development of new and the improvement of existing systems of communications and information transmission by means of the introduction of cable, radio relay, and lightguide communications channels; digital transmission and electronic switching, the extensive use of computer hardware and electronics, which ensures the high speed and reliability of information transmission and the formation of the information and computing infrastructure;

—the formation of databases and knowledge bases of different types (general access, regional, specialized, and so on) on the basis of the system of the automated acquisition and input of primary information and the corresponding set of measuring, analytical, and control equipment, which makes it possible to make direct contact both with processes and with computer hardware;

—the development and improvement of the architectures of various types of information and computing systems (control, retrieval and reference, simulating, instruction), which are capable of adaptation and reorganization in conformity with the requirements of the user and ensure the most efficient use of means of electronization in various areas of the national economy.

The solution of technical problems of this sort within the previously examined long-range trends in the area of the use of means of electronization will enable the national economies of all the countries of the socialist community to shift to a new, substantially higher socioeconomic level of development and to ensure the radical increase of the productivity and efficiency of social labor, the equalization of the levels of development of all the fraternal countries, and their economic and political independence.

On the Advantages of Cooperation and the Systems Approach

The most effective means of achieving such an imposing goal is the scientific, technical, and production cooperation of the countries of the socialist community and the coordination of efforts within the Comprehensive Program of Scientific and Technical Progress, in which electronization has been included as the first priority direction. The developed capitalist states of Europe are now following in this direction, having formulated on the basis of the Eureka Program the priority direction "Electronization."

The joint efforts of the CEMA member countries on the implementation of the Comprehensive Program of Scientific and Technical Progress are concentrated on the increase of the technical and economic characteristics of means of electronization and computer hardware, the increase of the possibilities of production automation, and the radical reform of the information and technical base of the management of the national economy and its units by the extensive and efficient use of modern computers and means of information science and telecommunications. During the implementation of the Comprehensive Program of Scientific and Technical Progress the CEMA member countries intend to solve the problems of the joint development and production (on a scientifically sound scale) of a large range of computers, which are furnished with the latest peripheral equipment, effective programs, and a reliable element base, as well as to develop advanced means and systems of communications. This will make it possible to develop a unified technical base for the formation of integrated information and computing complexes of various levels and for various purposes and to ensure the reliable operation and interaction of such complexes within sectorial, national, and international computer networks.

To what extent do the problems, which have been included in the first priority direction of the Comprehensive Program of Scientific and Technical Progress, conform to the assessments of the development of electronization at the beginning of the next century? The comparison of the subdivisions that have been singled out in the Comprehensive Program of Scientific and Technical Progress (the development of computer hardware and programs, a standardized element base, systems electronization, communications and information transmission systems, instruments for obtaining primary information) with the basic directions of the long-range development of means of electronization shows their nearly complete coincidence.

Thus, the development and mass production of series of computer hardware, which is compatible with respect to equipment—from high-performance supercomputers, which are the base computers of large collective-use computer centers and computer networks, to microcomputers for the automation of workplaces, which constitute the base of flexible machine systems—are envisaged in the section which is devoted to computer hardware and programs. Further it is a question of the organization of the industrial production of program products, which are most compatible for computers of various series and generations.

The development and series production of inexpensive, reliable, and compact items, as well as the development of effective technologies of their production are outlined in the section on the development of a standardized element base. The goal of the next section is the introduction of unified systems of switching equipment and means of digital information transmission over communications lines (including over fiber cables and by means of earth satellites) and the development of an automated communications system of the CEMA member countries

for the transmission of all types of information, including the exchange of information between computers in integrated computer networks. Here, as we see, an analogy with the above-described technical aspects of the long-range development of means of electronization is also observed.

And now let us dwell on the section of the Comprehensive Program of Scientific and Technical Progress "Problems of Systems Electronization." Unfortunately, it is oriented for the most part toward the development of various classes of information and computing systems. The questions, which regard electronization as a complex system, remained outside it.

In our opinion, it would be advisable to supplement this section, by introducing into it the problems of systems scientific, technical, economic, and social forecasting, as well as the problems of the formation of the information and computing infrastructure with allowance made for the comprehensive approach to the use of means of electronization.

In the very near future the performers, who are taking part in the elaboration of the problems of electronization, will discuss questions which specify and supplement the Comprehensive Program of Scientific and Technical Progress. It is desirable that the problems, which correspond to the long-range trends of development of electronization of the CEMA member countries beyond the present century, would be included among them.

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CEMA Cooperation in Communications, Information Transmission

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[Article by Laszlo Kovac, chief of a department of the CEMA Secretariat, under the rubric "The Comprehensive Program of Scientific and Technical Development: The Strategy of Acceleration": "The Communications System and Information Transmission"; first two paragraphs are EKONOMICHESKOYE SOTRUDNICHESTVO STRAN-CHLENOV SEV introduction]

[Text] Scientific and technical progress, being an objective process of social life, at present is relying on the exceptionally rapid development of information science.

The reliability and speed of information transmission are acquiring greater and greater significance in the accomplishment of the most diverse tasks in the national economy, in the planning and management of production on the scale of the sector and production economic units, in the automation of various technological processes, in the supply of production and the population, in vocational training, in the medical, municipal, and personal service of the population, and so on.

Information science, which includes information acquisition and processing equipment (various types of computers and their peripheral devices) and equipment of its transmission (transceiving equipment, switching equipment, and communications lines) and the control of its flows and complex systems (programs), in recent decades has covered the path of truly revolutionary development.

Microelectronics is making it possible to place a larger and larger number of electronic components on silicon wafers measuring several square millimeters, while photonics, or, as it is more often called, lightguide technology, is making it possible to transmit an enormous amount of information by means of glass fiber. Recent experiments have shown that it is possible to transmit about 2 billion bits of information a second over more than 100 kilometers through a single optical fiber without intermediate amplification.

Considerable attention at present is being devoted to software (programs), for the development of which more monetary assets are already being allocated than for information acquisition, processing, and transmission equipment.

The rapid development of information science, which is penetrating more and more deeply into all spheres of human activity, is defining in a fundamentally new way the role and significance of electrical communications.

Communications is one of the most important elements of the production infrastructure, which has a significant influence on the development of all sectors of the national economy. Therefore, in recent decades communications, especially electrical communications (the production of communications equipment and its service), has become one of the most dynamically developing sectors of the world economy, including the economy of the CEMA member countries.

Today communications is one of the largest (with respect to the equipment being used and the number of employees) subsystems of information science, the individual parts of which should act in concert not only within one city, region, or country, but also on an international scale.

It is possible to divide the entire communications network into three basic elements: terminal (subscriber) devices, transmission systems, and switching systems.

At present sound, images, written and graphic information, as well as data are transmitted through various, independent networks.

Until recently information transmission was accompanied by the conversion of speech into an analog electrical signal. The same thing happens in case of the transmission of moving images. Analog communications networks are a significant achievement of engineering thought. They have existed for a long time now, and a myriad of equipment of different types, which operates on a different element base, is available.

Communications equipment in recent years has developed especially rapidly both with respect to the amount of equipment being used and the volume of information being transmitted and with respect to the technical level. The number of telephone numbers in the world doubles every 10-12 years (an average annual growth rate of 6-7 percent). The expansion of the communications network, that is, the increase of the number of transmission lines, is also connected with such growth. However, the increase of their length is occurring three- to fourfold more rapidly than the number of subscriber numbers, due to the increase of the distance of communications both within the country and on the international scale.

Specialists have come to the conclusion that it is impossible to develop communications networks by the extensive means, that is, by the increase of only the number of subscriber numbers and the transmission lines which correspond to them, as well as simultaneously various, independent information transmission networks, while it is necessary to connect them into a single (integrated) network. Finally, at the same time as the development of networks it is necessary also to carry out their qualitative change—the integration of communications equipment with computer hardware, which will increase the functional possibilities of facilities (networks) of both communications and computer technology.

The successes of microelectronics have made it possible instead of an analog signal to transmit binary code numbers which correspond to the periodic values of the amplitude of the speech signal. The transition from the analog to the digital information processing system and the development of high-speed transmission and switching systems have made it possible at the present stage to begin the solution of the named problems.

The aspiration for the maximum use of microelectronic elements and high-density integrated circuits (large-scale integrated circuits) and for high reliability is the basis for the development and production of digital systems. Only in this way is it possible to increase the efficiency of the production and use of digital systems, as well as to increase the speed and number of channels for the development of a transmission system at higher levels.

Along with conventional telephone communications other modes of data transmission are also being rapidly developed: cable television and information systems, equipment, which supports the holding of meetings and conferences by means of television, systems of communication between computers, and so on.

Joint Activity

The cooperation of the CEMA member countries encompasses the specialization and cooperation of production and reciprocal deliveries of means of wire and radio relay communications, radio broadcasting and ground mobile radio communications, television transmission and reception, automatic air traffic control systems, as well as specialized technological equipment and instrumentation for their production and components, which are contained in the list agreed upon by the countries of the Unified Standardized Base of Items of Electronic Engineering.

The extensive supply of all spheres of production and social life with the most advanced computer hardware and communications equipment is the basic goal of cooperation. For its achievement such tasks as the establishment of standardized, unified communications systems, which ensure the sharp increase of capacity and reliability, their use in the national systems of the fraternal countries, and the formation of their Interconnected Automated Integrated Communications System (VAKSS) are posed in the Comprehensive Program of Scientific and Technical Progress. The need has arisen for the acceleration of the pace of development of communications systems on the basis of the latest achievements of scientific and technical progress. This is due to the fact that the average growth rate of transmitted information in the world, including in the CEMA member countries, exceeds the rate of increase of the basic economic indicator—the national income. The retooling of communications networks on the basis of the latest achievements of scientific and technical progress in microelectronics, computer technology, optoelectronics, and space technology is already under way in the industrially developed countries. In recent times digital electronic equipment has been finding more and more extensive use in communications, in sound-reproducing devices, and in other household and service instruments.

The work on the development of communications systems in the organs of the Council began long before the adoption of the Comprehensive Program of Scientific and Technical Progress. The 41st meeting of the CEMA Permanent Commission for Cooperation in the Radio and Electronics Engineering Industry, at which the drafts of three intergovernmental agreements, which were signed in July 1981 in Sofia, on multilateral cooperation in the development and introduction in production of the Unified System of Switching Facilities (YeS SKT), the Unified System of Digital Information Transmission Facilities (YeS STsPI), and the Unified Standardized Base of Items of Electronic Engineering, Special Technological Equipment, and Semiconductor and Special Materials for Their Production were approved, was held in June 1981 in Moscow.

The Unified System of Digital Information Transmission Facilities is standardized complexes of hardware based on unified technological design principles, a unified element base, unified materials, and a unified

method of uniting digital flows. The coordination of the development and introduction in production of the Unified System of Switching Facilities and the Unified System of Digital Information Transmission Facilities is being carried out by the councils of chief designers, which are headed by general designers from the USSR, in conformity with the programs of cooperation of the interested CEMA member countries in this field.

Scientific and technical research and development are carried out by national organizations, while coordination is carried out on the basis of bilateral and multilateral agreements between competent organizations of the fraternal countries. They take part in the development and introduction of individual hardware components in accordance with their interest. The specialization of the production and reciprocal deliveries of digital information transmission facilities are included in the draft of the agreement on the specialization and cooperation of the production of wire and radio relay communications equipment for 1986-1990 and to 2000 and are being included in long-term foreign trade agreements and protocols.

This will make it possible:

—to meet the specific demands on electrical communications equipment, which follow from the plan of the Interconnected Automated Integrated Communications System;

—to use the equipment in all the fraternal countries owing to the standardization of the technical and operating demands on it, as well as to interchange the equipment being used in different countries;

—to coordinate the dates of fulfillment of technical and economic measures by enterprises of industry and electrical and postal communications, which will lead to the shortening of the time of the development and introduction in operation of the corresponding equipment.

The full interconnection of the Unified System of Digital Information Transmission Facilities with the Unified System of Switching Facilities is envisaged. The equipment, which is being included in the Unified System of Digital Information Transmission Facilities, will ensure the transmission of telephone, telegraph, phototelegraph, and television signals, as well as newspapers. The Unified System of Digital Information Transmission Facilities will enable the organization of channels and paths of the necessary range for local intrazonal and main communications networks.

The introduction of digital equipment in conformity with the Unified System of Lightguide Information Transmission Facilities (YeS SSPI) will make it possible to organize communications networks in a new way and to establish so-called integrated digital communications networks.

The Unified System of Switching Facilities envisages the establishment of small-, medium-, and large-capacity automatic telephone exchanges (ATS's), subscriber concentrators, special control computer complexes, and peripheral equipment for automatic telephone exchanges (line switches and maintenance subsystems).

As a result of the joint activity of specialists of the countries of the community a systems concept of the building of automatic telephone exchanges on the basis of modules with decentralized control was agreed on. The work, which is envisaged by the Unified System of Digital Information Facilities, at present is at the stage of the development of equipment for a pilot region, which it is planned to single out on the territory of the USSR, while the work being planned in accordance with the Unified System of Switching Facilities is at the stage of the preparation of detail designs of modules for automatic telephone exchanges for various purposes.

It is assumed that by 1990 the annual increase of reciprocal deliveries of equipment of digital communications engineering will come to 25-30 percent.

The introduction in communications networks of digital switching facilities and the production of the corresponding standardized items of electronic engineering are having a substantial influence on the increase of deliveries of digital information transmission facilities in accordance with the agreement on the international specialization and cooperation of production for 1986-1990.

Fiber Optic Communications Is a Step Into the Future

In examining the prospects of cooperation of the CEMA member countries in the development of the production and the use of the latest communications equipment, one should speak separately about the lightguide system of communications and information transmission, the development and extensive use of which are also envisaged by the Comprehensive Program of Scientific and Technical Progress to 2000.

Approximately 500 million telephone subscribers, 1 million telegraph subscribers, and hundreds of thousands of information centers exchange information several times a day.

At the same time as conventional telephone communications other methods of data transmission are also being rapidly developed: cable television and information systems, equipment, which supports the conducting of meetings and conferences by means of television, systems of communication between computers, and so forth. All this requires enormous material expenditures on their development and maintenance.

About half of the copper smelted in the world and a fourth of the produced lead are used at present for the production of communications cables. The developments of recent years, which were aimed at the saving of natural resources, led to significant qualitative changes in communications equipment. Thus, optical communications is of truly revolutionary importance. The appearance in 1960 of the laser had an enormous influence on modern science and technology. The appearance of semiconductor lasers, the possibility of the production of fiber optic lightguides with low losses (attenuations), and the use of digital methods of information transmission contributed to the rapid development of scientific research and development in the field of optical communications.

The invention of the laser aroused extensive interest in the use of light for the solution of problems, which were previously regarded as the privilege of radio and electromagnetic waves of the microwave band. The high carrier frequency of infrared radiation attracted attention.

Three frequency bands are optimal for information transmission through lightguides: 0.85, 1.3, and 1.6 micrometers. The minimum values of attenuation (loss of legitimate signal), which are equal respectively to 2, 0.5, and 0.2 decibels per kilometer, have been achieved here. In practice for cables actually being laid these values are slightly higher.

At present it is possible to consider the wavelength of 0.85 micrometers to be assimilated, the testing of a more effective wave—1.3 micrometers—is being actively carried out, while 1.5 and 2 micrometers are at the initial stage. Research in the band from 2 to 10 micrometers promises even better results.

A lightguide is slightly thicker than a human hair. However, as compared with other systems of electrical communications optical transmission has many advantages. First of all one should note the possibility of the transmission of images and its broadbandness, which makes it possible to multiplex (up to several thousand telephone channels per lightguide), while the low losses accordingly make it possible to increase the relaying segment (in which signals are transmitted without their amplification and regeneration). Lightguide communications systems ensure the transmission of information over long distances.

The advantages of lightguides are especially perceptible when used under conditions which are adverse from the standpoint of electromagnetic interference. They are immune to the effect of this interference and stable in operation in case of the change of ambient conditions, particularly temperature and moisture, and in practice are not sensitive to the effect of extraneous electromagnetic interference.

The absence of electrical conduction eliminates the occurrence of malfunctions and fires in communications devices due to short circuits. Since the disconnection of potentials exists between generators and the receiver, bugging is eliminated in lightguide systems.

The need for the protection of lightguides against external actions makes it incumbent to use them only in cables with protective and strengthening sheaths. In spite of this lightguide cables have a small diameter and small mass as compared with metal cables: only 100-150 tons as compared with the fact that it operates at a transmission speed of 560 megabits a second with a weight of 4,500 tons.

The economic advantages of lightguide communications systems appears fully only in combination with electronic digital methods of transmission. In case of the full transition to digital systems of the distribution and transmission of telephone conversations the expenditures are reduced to approximately one-tenth as compared with the former ones.

In 1970 the development of lightguides and fiber optic communications lines on the basis of the development and introduction of ultrapure materials was begun in the world, including in the CEMA member countries.

The mass production and use of lightguide communications facilities are a difficult problem, and it is possible to solve it by joint efforts in case of the efficient distribution of tasks among the CEMA member countries.

Guided by the decisions of the Economic Summit Conference of the CEMA Member Countries (June 1984) and the Comprehensive Program of Scientific and Technical Progress, for the development and intensification of the international socialist division of labor in meeting the need of the fraternal countries for promising equipment in December 1985 Bulgaria, Hungary, the GDR, the Republic of Cuba, Poland, Romania, the USSR, the CSSR, and Yugoslavia concluded the General Agreement on Multilateral Cooperation in the Area of the Development and Introduction in Production and the Operation of the Unified System of Lightguide Information Transmission Facilities. The need for closer cooperation in the development, standardization, production, and operation of lightguide means of the transmission of all types of information for the formation of the Interconnected Automated Integrated Communications System and the development of national communications networks is taken into account in this agreement.

The Unified System of Lightguide Information Transmission Facilities is a standardized set of equipment based on unified technological design principles of the element base, materials, fiber cables and means for their laying and installation, means of measurement and control, special technological equipment, and autonomous

power supplies. The Unified System of Lightguide Information Transmission Facilities will use standardized channel- and group-forming equipment, which has been developed in conformity with other agreements on multilateral cooperation of the CEMA member countries.

After the adoption of the Comprehensive Program of Scientific and Technical Progress in CEMA organs, particularly in the CEMA Permanent Commission for Cooperation in the Radio and Electronics Engineering Industry, immense work was performed on uniting the actions of a large number of scientific and production organizations of the fraternal countries for the successful accomplishment of the tasks of the development of the production and use of the latest communications equipment.

The general agreements already in effect have been analyzed, detailed programs of the development, testing, and production of various communications equipment and its modules and elements on the basis of the socialist division of labor and international specialization and cooperation have been formulated and specified.

The main organizations, which are responsible for the coordination of work on individual problems and themes of the Comprehensive Program of Scientific and Technical Progress, have established direct contacts with scientific production organizations of the other CEMA member countries, which are participating in the development and cooperated production of individual elements and communications equipment. It is envisaged to conclude (just on the problem of the development of communications equipment) more than 100 civil law agreements, which regulate the specific tasks and responsibility in the development of communications equipment of economic and production organizations and enterprises of the interested CEMA member countries.

The Comprehensive Program of Scientific and Technical Progress of the CEMA Member Countries to 2000 provided a powerful stimulus for the launching of the multilateral specialization and cooperation of industry of the fraternal countries, which produces items of electronic engineering and communications equipment.

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CEMA Cooperation in Electronics

18140142b Moscow EKONOMICHESKOYE SOTRUDNICHESTVO STRAN-CHLENOV SEV in Russian No 1, Jan 87 pp 40-43

[Article under the rubric "The Comprehensive Program of Scientific and Technical Progress: The Strategy of Acceleration": "In the Direction of Electronization"; first paragraph is EKONOMICHESKOYE SOTRUDNICHESTVO STRAN-CHLENOV SEV introduction]

[Text] The successes of the socialist community in the implementation of the other priority directions, which are envisaged in the Comprehensive Program of Scientific and Technical Progress, depend to a significant degree on the results achieved by the countries in the development and production of electronization equipment.

All the CEMA member countries are taking part in the practical accomplishment of the tasks of the Comprehensive Program of Scientific and Technical Progress in the area of electronization. By the end of 1986 they had signed 32 agreements (contracts), 11 protocols on the supplementing and specification of prevailing agreements (contracts), and about 40 contracts. A number of international documents are at the stage of coordination.

According to preliminary estimates, by 1990 more than 700 assignments, of which about 600 will conclude with introduction in production, will be fulfilled.

At present the basic attention is being devoted to the organization of production cooperation, first of all with respect to items which are being developed within the Comprehensive Program of Scientific and Technical Progress in 1987. The CEMA member countries are ascertaining the mutual needs and production possibilities and on their basis are preparing contracts on multilateral specialization and cooperation or protocols on the supplementing of prevailing agreements.

The economic interests of the countries at the level of economic organizations is the motive force in the organization of cooperation on the fulfillment of the assignments of the Comprehensive Program of Scientific and Technical Progress. Therefore, for stable cooperation and the introduction of new equipment and technology the fraternal countries are using extensively direct ties between related enterprises and organizations, while for the purposes of the more efficient use of the results of the international division of labor are establishing joint enterprises and international associations.

The large-scale cooperation of the CEMA member countries, which is being developed at present in the fulfillment of the assignments of the Comprehensive Program of Scientific and Technical Progress, is called upon to provide all spheres of production and public life with the most advanced electronization equipment. The priority tasks in this area are aimed at the development of:

—the Unified Standardized Base of Items of Electronic Engineering (YeUB IET);

—diverse computer hardware, especially personal computers, with developed programs;

—the Unified System of Switching Facilities (YeS SKT);

—the Unified System of Digital Information Transmission Facilities (YeS STsPI);

—the Unified System of Lightguide Information Transmission Facilities (YeS SSPI) and so on.

On this basis it is envisaged to increase significantly the average annual growth rate of the national income and labor productivity in all fields of activity, including industry, construction, agriculture, transportation, health care, education, trade, and services. At the same time it is planned to decrease to one-half to two-thirds the materials- and power-output ratios. Advanced communications equipment in combination with computer hardware (VT) should ensure a saving of capital investments in production, the decrease of production expenditures, and the reduction of the size of the management staff. The use of information computer systems will make it possible to shorten to one-third to one-half the time of the formulation and implementation of scientific programs and engineering and technical designs with the simultaneous increase of quality and the significant decrease of expenditures on their fulfillment. Owing to computer hardware the efficiency of the training and advanced training of personnel will increase and the quality of the medical, municipal, and personal service of the population will improve. Electronics, which is being used extensively in production and in daily life, will free a significant portion of the population from manual and uncreative work and will improve the social conditions of the workers of the CEMA member countries.

Now, when a little more than a year has passed since the adoption of the Comprehensive Program of Scientific and Technical Progress, it is necessary not only to analyze the achieved results and to sum up the first totals of the joint work, but also to designate the most important objects, on which the efforts of the CEMA member countries should be concentrated.

The fraternal countries have formulated and coordinated detailed programs of cooperation on practically all the problems of the priority direction "The Electronization of the National Economy."

Today a matter of foremost importance is the inclusion of the assignments of the Comprehensive Program of Scientific and Technical Progress in the national plans for 1987 and for the five-year plan as a whole. Only in this case is it possible to provide these assignments at all stages—from scientific research to the series production of new products—with the necessary financial, manpower, material, and technical resources, as well as capital investments and production capacities.

In the CEMA organs, which are responsible for cooperation on the problems of electronization, much attention is being devoted to the estimation of the needs for new products and the volumes of their industrial production, first of all on the basis of specialization and cooperation. The achieved understandings are being formalized by the corresponding agreements. With allowance made for them the central planning organs of the CEMA member countries will make changes as needed in the results of the coordination of the national plans for 1986-1990 and the following period.

It is well known what importance is now being attached to the development of advanced items which conform to the best world models. This is all the more important when it is a question of computer hardware, communications equipment, electronics, instruments, and control systems of production and nonproduction processes. For the success of the accomplishment of the assignments in other directions of the Comprehensive Program of Scientific and Technical Progress in the final analysis depends on them. For example, a lag of the technical level has been "incorporated" in places in the control systems now being developed. While this in turn will not make it possible to achieve the highest world indicators in the NC machine tools, robots, and flexible production systems (GPS's), which are being designed.

How is the accomplishment of the assignments of the Comprehensive Program of Scientific and Technical Progress, which are connected with electronization, being carried out? Let us examine several results. For example, much is being done on the development of the Unified Standardized Base of Items of Electronic Engineering. The development, production, and reciprocal deliveries of integrated circuits, special technological equipment, and ultrapure materials are envisaged for this purpose. In all more than 1,000 instruments are included in the unified standardized list of items of electronic engineering. The CEMA member countries are meeting the reciprocal needs for them on the basis of multilateral and bilateral agreements on specialization and cooperation. In particular, 571 items of electronic engineering and 52 types of special technological equipment for their production are reflected in the multilateral agreements which are in effect during the current 5-year period.

The fulfillment of the general agreement on the establishment of the Unified Standardized Base of Items of Electronic Engineering (1981) will make it possible during 1986-1990 to increase by nearly twofold the volume of reciprocal deliveries as compared with the preceding 5-year period.

During the implementation of the agreement on microelectronics, which was concluded in 1982, more than 200 types of large-scale and very large-scale integrated circuits were developed and introduced. By 1990 it is envisaged to develop and assimilate in series production about 160 types of them, including 16-bit and 32-bit microprocessor sets, programmable logic arrays, memories, integrated circuits of increased reliability, and other items, which ensure technical and economic indicators at the level of the best world achievements. At the same time this will make it possible to reduce to one-fifth to one-half the weight and dimensional characteristics of

hardware, to increase the speed by tenfold and more and the reliability by ten- to twentyfold, and to reduce the power consumption to one-fifth and less.

It is planned to increase the deliveries of microelectronic items between the CEMA member countries during 1986-1990 by nearly threefold as compared with 1981-1985.

The agreement on the multilateral international specialization and cooperation of the development and production of computer hardware (SVT) for reciprocal deliveries is playing an important role in the implementation of the Comprehensive Program of Scientific and Technical Progress. Signed on 19 June 1980 within the Intergovernmental Commission for Cooperation of the Socialist Countries in Computer Technology (MPK po VT), it specifies the basic directions of the international socialist division of labor in this field to 1990.

In the course of cooperation more than 500 types of advanced hardware and software of the Unified System of Computers (large computers) and the System of Small Computers (minicomputers and microcomputers) and a number of personal computers have been developed and assimilated by industry.

At present the computers of the Unified System, which are being used in all sectors of the national economy, constitute the base of the pool of computers of the CEMA member countries, which has made it possible in practice to completely abandon the importing of large computers from capitalist states. The fraternal countries plan to increase during 1986-1995 the reciprocal deliveries of computer hardware to 25 billion rubles, that is, to increase them by 15 percent as compared with 1981-1985.

Among the most important tasks of the Comprehensive Program of Scientific and Technical Progress is the development of a supercomputer, which has the highest performance indicators and is intended for the solution of especially difficult problems of science, technology, and control. The formulation of a coordinated scientific and technical concept in this area is being completed. With allowance made for the assignments of the Comprehensive Program of Scientific and Technical Progress the corresponding adjustments are being made in the development of the Unified System of Ryad-4 Computers and the System of Small Computers of the Fourth Stage.

The deadlines of the production of individual models of computers and computer complexes with a performance of up to 1 billion operations a second, which are based on the use of principles of artificial intelligence, and minicomputers with a performance of up to 5 million operations a second with a set of peripheral devises for use in flexible production systems, computer-aided design systems, automated systems of scientific research, plant technical management automation system, and integrated automated control systems have been specified.

It is planned by the Intergovernmental Commission for Cooperation of the Socialist Countries in Computer Technology to develop more than 40 different types of personal computers, moreover, individual modules of them will be produced already in 1987. Then the production of intelligent peripheral devices, graphic input (output) devices, as well as teleprocessing equipment will begin.

The intergovernmental agreement on the development and introduction in production of the Unified System of Switching Facilities (1981) is of great importance for the fulfillment of the assignments of the Comprehensive Program of Scientific and Technical Progress. Its hardware and programs are intended for the construction of communications networks of the CEMA member countries on the basis of electronic automatic telephone exchanges (EATS's) and unified technological design decisions, which are being used in the interconnected automated integrated communications system for the transmission of all types of information. The agreement specified the international division of labor among the partners in cooperation.

The work in the Council of Chief Designers of the Unified System of Switching Facilities is being set up. By 1990 it will be carried out on the basis of 14contracts, a portion of which have been signed. The development of individual modules and assemblies of this system is already under way in the countries. It is planned to carry out the testing of prototypes in 1992.

The intergovernmental agreement on the development and introduction in production of the Unified System of Digital Information Transmission Facilities (1981) also has a direct bearing on the assignments of the Comprehensive Program of Scientific and Technical Progress. The development of unified technological design principles, the element base, and materials is being carried out on a contractual basis by the Council of Chief Designers of the Unified System of Digital Information Transmission Facilities. So far a number of instruments have been produced and tests of them have been conducted, the volumes of reciprocal deliveries of eight types of corresponding equipment have been agreed on.

Finally, another important area of cooperation is connected with the fulfillment of the general agreement on the development, production, and operation of the Unified System of Lightguide Information Transmission Facilities. It was signed during the work of the 41st (extraordinary) meeting of the CEMA Session, at which the Comprehensive Program of Scientific and Technical Progress was adopted.

The Unified System of Lightguide Information Transmission Facilities is a standardized set of hardware, which is being developed on the basis of unified technological design principles, a common standardized element base, materials, standardized fiber cables and instrumentation, special technological equipment, and autonomous power sources. The introduction of fiber optic systems will make it possible to increase significantly the capacity of communications lines, to save scarce nonferrous metals, to reduce operating costs, and to improve the dimensional characteristics of hardware. Owing to the Unified System of Lightguide Information Transmission Facilities information transmission will be raised to a qualitatively new level.

Thus, the CEMA member countries have begun the practical accomplishment of the tasks of the Comprehensive Program of Scientific and Technical Progress. Work is being performed on the preparation and conclusion of new agreements and contracts. However, the pace of the implementation of the Comprehensive Program of Scientific and Technical Progress for the present is still inadequate.

At the stage of the coordination of agreements and contracts it is desirable to specify the approximate needs of the countries and the interest of the countries in the development of the specialized and cooperated production of the products being developed.

It is advisable to formulate coordinated steps of the development of the production capacities of the CEMA member countries for the production of new electronization equipment for meeting the needs of the other priority directions of the Comprehensive Program of Scientific and Technical Progress. The time has come to begin the formulation of unified organizational, procedural, economic, and legal principles of the development of direct ties and the establishment of joint enterprises.

Economic organizations cannot always settle these questions independently. They need for this the assistance of ministries and departments, planning organs, and the ministries and departments for science and technology of the CEMA member countries.

All these questions are being settled extremely slowly. This is hindering the conclusion of agreements and contracts. The most active intervention in this process of CEMA organs, especially those which are responsible for the organization of cooperation in the priority directions of the Comprehensive Program of Scientific and Technical Progress, is necessary. It should be noted that for the present the majority of them are not taking an active position in this matter.

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Priority Directions of Hungarian Development

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[Article by Academician Pal Tetenyi, chairman of the Hungarian National Technological Development Commission, under the rubric "Integration Is the Multiplication of Forces": "Hungary: The Basic Priorities of Development"]

[Text] In conformity with the decisions of the 13th Congress of the Hungarian Socialist Workers Party and the Law on the 7th Five-Year Plan of Development of the Hungarian National Economy the increase of the efficiency and international competitive ability of production by means of the improvement of qualitative factors and the acceleration of technical progress and structural changes of the economy should become the basic direction and source of progress of the economy. The progress of society and the economy to an ever increasing extent requires the increase of the efficiency of scientific research and technical development.[1]

During 1986-1990 it is necessary to improve the productivity of living and embodied labor by 17-19 percent and to increase the national income per employee by 21-23 percent. The specific consumption of materials should be reduced by 3.5 percent and of energy by 12 percent. This should become the basic prerequisite so that during the next 5 years the national income would increase by 15-17 percent and domestic consumption would increase by 12-14 percent and so that the consumption of the population in 1990 would exceed the 1985 level by 8-10 percent, while capital investments would exceed it by 28-29 percent.

In the national income of the country the proportion of exports is very large. In 1985 it came to 50 percent. Consequently, the planned increase of the entire national income can also be accomplished in case of an increase to a certain degree of exports. That is why the international competitive ability of Hungarian products—the level of their price (production cost) and quality—is of extraordinary importance for the economic development of the country.

From this it follows that the intensive development of the economy, which is envisaged during the 7th Five-Year Plan, can be accomplished only if the lag behind the leading level of technical and economic progress as a whole does not increase, while in certain areas the technical level gradually approaches the world level, if the introduction of the latest scientific and technical innovations is expedited.

The achievement of the goals of socioeconomic development is possible only by the expansion of international production, scientific, and technical cooperation and the intensification of the division of labor. The amount of the national expenditures on scientific research, as well as the positive and negative aspects of the long-term experience of the technical development of our country testify to this.

Hungary is very interested in importing from other CEMA member countries as large a number as possible of results of scientific and technical research and items of a high technical level and in increasing the scientific and technical potential of the country by cooperation with these countries in the development of advanced technology and the specialized production of items of a high technical level, which can be sold profitably on broad markets.

The Hungarian People's Republic is interested in increasing the efficiency of its own scientific research work by participation in large-scale international programs, first of all in the Comprehensive Program of Scientific and Technical Progress of the CEMA Member Countries to 2000 (KP NTP).

Science and technology policy and the practical experience of achieving the goals of the 7th Five-Year Plan are aimed, on the one hand, at the creation of general conditions, which expand the scientific base of technical progress and improve the economic conditions of technical development, and, on the other, at the promotion of this development in the most important directions by the specification of the basic tasks and the formulation and implementation of programs.

The Conditions of Scientific and Technical Development

The basic directions of research, including basic research, and technical development are specified by the law on the National Economic Plan. In it the importance of basic research for the increase of the material possibilities of its conducting is emphasized, the establishment of a special State Fund of Scientific Research, which the Hungarian Academy of Sciences (VAN) distributes by open competition, is envisaged. The scientific urgency of the theme and the level of the preceding activity of the claimant are the criteria of the evaluation of competitive applications for basic research.

The expenditures on scientific research, including basic research, may come to about 3 percent of the national income. Here much attention is being devoted to the improvement of the supply of research with instruments and machines.

The compiling and fulfillment of central plans of the development of the economy are contributing to the modernization of the national economy. In conformity with such programs enterprises can obtain on the basis of

competition for capital investments preferential credits and breaks on taxes and duties for several items. Moreover, specific forms of material incentives can also be used, while interested budget-carried organizations receive additional opportunities for capital investments. Such programs have been adopted in the area of the saving of energy and materials, the development of electronics, and the production of pharmaceutical products, chemical means of plant protection, and semifinished chemical products.

The basic principles of state science and technology policy for the 7th Five-Year Plan on the development of the network of scientific research institutes and personnel and on problems of international scientific and technical cooperation are specified in the state 5-year science and technology plan.

The basic scientific and technical goals and the priority directions of development are presented in detail in the plan. It contains 14 statewide scientific research programs. One of them provides for basic research on biotechnology, four—on the social sciences. Nine programs encompass scientific and technical research for the solution of specific economic problems, the results of which will be introduced in practice. It is presumed that all the technical and economic prerequisites exist for this.

Within the statewide scientific and technical program 25 percent of all the spending, which is intended for the development of science and technology during the 7th Five-Year Plan, will be used. The implementation of individual ones of these programs is under the jurisdiction of ministers, the chairman of the Hungarian National Technological Development Commission (GKTR), or the general secretary of the Hungarian Academy of Sciences. The detailed theme of each program is specified by its council, which consists of the minister responsible for the program and representatives of interested ministries and the large enterprises which finance the program. Technical (or scientific) committees of specialists operate under the councils.

In accordance with the program individual scientific research themes are financed in conformity with contracts, which are concluded between the Bureau of the Program and an enterprise, scientific research institute, or chair of a higher educational institution. In the same way the Bureau of the Program concludes contracts for the fulfillment of scientific research themes, which are envisaged by the Comprehensive Program of Scientific and Technical Progress, if the performing organization cannot fulfill the work at its own expense and turns to the Bureau of the corresponding statewide program for the theme to obtain assets from central funds. The Bureau also carries out the monitoring of fulfillment.

A special program was formulated for the development of the infrastructure of scientific and technical activity and technical development. It presumes the modernization of the system of information, the development of the methods of computer-aided design and the broadening of the range of their application, the improvement of the tool base of quality control institutions, and the increase of the rental of scientific instruments and the network of experimental shops and pilot plants.

The Network of Scientific Research Institutions. In 1985 in Hungary scientific research and activity, which are conducive to technical development, were conducted at 68 scientific research institutes, 937 chairs of higher educational institutions, 95 enterprises of the engineering type, 215 production enterprises, and others.

One should specially note the work of the seven innovation banks, which support with preferential credits the introduction of scientific and technical achievements. In addition to financing research and development they promote with small capital investments the introduction of new products and the organization of their market.

The most important scientific policy goals of the 7th Five-Year Plan are the expansion of the scientific and technical potential and the improvement of the conditions of scientific research work at enterprises and higher educational institutions and the facilitation of the conditions of the establishment of various scientific research associations with the participation of production enterprises, as well as organizations, which specialize in the fulfillment of specific tasks.

In 1985 about 77,000 people worked at scientific research institutes, laboratories of enterprises, chairs, and enterprises of the engineering type. In the past 5 years in accordance with a decision of the government the number of scientific personnel has been reduced by 7,000. A further reduction is not envisaged, but the accomplishment of the new tasks should be ensured by the regrouping of personnel, without the increase of their total number.

The Financing of Scientific Research Work. About 22 percent of the spending, which is envisaged for scientific research activity (including basic research), is provided by the state budget. A certain portion of the expenditures of institutes of the Hungarian Academy of Sciences and the research institutes of agriculture and geology is covered by this. A portion of the expenses of chairs of higher educational institutions is also financed from the budget.

About 23 percent of the expenses are covered by means of the centralized fund of technical progress, which was formed from contributions of enterprises. In this case the amount of the contribution is proportionate to the value of the output of the enterprise. Ministries and the National Technological Development Commission allocate from this fund a significant portion of the expenditures, which are necessary for the fulfillment of statewide and sectorial programs and for the development of the

research infrastructure. Specific projects on the technical development of the enterprise are also financed (jointly with it) from this fund. A certain portion of the fund is used as interest-free credit.

About 55 percent of the expenditures on scientific research activity are financed from the sources of enterprises. The expenditures on work and on the acquisition of scientific equipment are considered production costs and are included in the total expenditures of enterprises. The establishment of plant funds of technical progress, which are equal to a specific percent (which differs by subsectors) of the net value of the output and are used only for the financing of scientific research work and the goals connected with it, is mandatory in the machine building and chemical industries.

During 1988-1989 it is proposed to abolish the mandatory formation of plant funds of technical progress, since enterprises can determine more precisely the amount of their expenditures for these purposes in conformity with the actual needs.

About 85 percent of the assets, which are envisaged for scientific research, are used in conformity with contracts, which are signed by enterprises, ministries, and program bureaus with scientific research institutes and chairs of higher educational institutions. Such contracts are often also concluded between enterprises.

For the increase of the interest in the use of scientific research results such a contractual form, within which the developing organization receives a specific share of the profit from the introduction of the result of its work at the enterprise, has been introduced and is being disseminated, although still not rapidly enough. A large portion of such a share (50-70 percent) can be used for paying bonuses to the participants in development and introduction.

The Economic Regulation of the Activity of Enterprises. The desire of enterprises to use the latest scientific achievements and to assimilate new technical results is governed first of all by the extent of their interest in the increase of the profit and the reduction of the production cost and by the degree of reflection of the qualitative differences and novelty in the prices of a product and in the income of those who work at the enterprise. Practical experience shows that the enterprises, which are taking part in the keen competitive struggle on the international market (the pharmaceutical industry, instrument making, agriculture), are interested to a greater extent in the use of innovations.

The set of economic regulators, which has been in effect since 1985, stimulates to a greater degree than before the increase of the technical level of items and production methods. Pricing has become more flexible. One of the forms of wage regulation (about 50 percent of the enterprises have chosen this form) makes it possible to turn a significant portion (60-70 percent) of the increase of the profit of the enterprise, which is obtained due to the increase of revenues, into an incentive of workers. The further dissemination of such a form of wage regulation is very desirable for the acceleration of technical progress.

The difficulty is that a significant portion of the revenues of the enterprise is deducted as various taxes and is regrouped into several unprofitable sectors of production. The possibility of developing advanced sectors is limited by this. That is why the elimination or at least the significant reduction of the losses of unprofitable sectors of the economy and the selective rapid development of promising works are one of the basic prerequisites of the acceleration of technical progress.

The Basic Goals and Priorities During the 7th Five-Year Plan

The basic directions of technical development consist in the use of:

—systems of advanced electronic equipment and in the extensive dissemination of electronization in the national economy and society;

—technologies, which contribute to the development and efficient use of biological systems and biologically active materials;

—materials- and energy-saving technologies.

A characteristic trait is the numerous connections between these directions. The special role of electronization in the efficient use of materials and energy and the connection of biological research and the development of agriculture, the food industry, and pharmaceutics can serve as an example.

Electronization. Its use is contributing to the development of the national economy and society as a whole. At present about 7,000 organizations have computers. In addition to 2,700 professional computers of various categories approximately 100,000 microcomputers are being used. The use of electronic equipment and computer hardware per 1,000 inhabitants comes respectively to 21 and 14 percent of the average West European level.

The task in this area is the provision of the scientific and technical base which is necessary for the achievement of the basic economic goals. First of all this applies to the development of semiconductor circuits and hybrid integrated circuits based on insulators, the introduction of the technology of surface mounting, the development of so-called passive electromechanical, vacuum-electronic, and other parts, technological equipment, and automatic measuring devices, as well as their introduction in new automated systems and the development of methods of the certification and testing of basic and auxiliary materials.

Research is being extended to promising systems of computer hardware, means of production automation, electronic production systems, robots, communications systems, and promising works, which substantiate development after 1990. A separate subprogram deals with the social prerequisites and consequences of electronization.

The development of telecommunications and the increase of telephone lines, automatic control centers, and teletype and information stations in the data acquisition and processing system serve the extensive introduction of electronics and computer technology.

The increase of the production of electronic equipment by 5-7 percent annually is envisaged. This surpasses the average pace of the planned increase of the output of the machine building industry.

Instruction in computer technology is being carried out systematically at all professional levels, including retraining. The training of specialists in electronics and computer technology is being expanded at secondary and higher educational institutions.

The fulfillment of 2 central programs of the development of the economy and 18 sectorial, 3 statewide, and 8 sectorial scientific research programs is contributing to the spread of electronization.

At present the specific tasks of scientific research, technical development, and production, which follow from the Comprehensive Program of Scientific and Technical Progress in the directions "Electronization" and "Integrated Automation," are being determined and specified. Hungarian specialists are taking part in the development of systems of fifth-generation computers, computer-aided design methods, fiber optic telecommunications, and robots. Hungarian organizations are participating in the solution of 44 problems of these 2 priority directions. About 50 Hungarian economic organizations are interested in such developments.

During the 7th Five-Year Plan about 12-15 percent of the capital investments and approximately 20-25 percent of the expenditures on research are being used for the accomplishment of the direct and indirect goals of the development and dissemination of electronics.

Biotechnologies. One central economic program and five statewide scientific research programs (including the program of basic research on biology) are aimed at the development of technologies, which promote the creation and efficient use of biological systems and biologically active substances. These goals account for 7-8 percent of all the expenditures on scientific research in the country. In the food industry, the production of chemical means of plant protection, pharmaceutics, and medicine many specialists of a high level have been trained. And in these areas the best methods, mechanism, and traditional means of the introduction of scientific research achievements, as well as the most effective international scientific and technical cooperation from an economic standpoint and the purchase and sale of licenses have formed.

The growth rate of the output of pharmaceutical production is planned to be higher than the average growth rate of industry as a whole. The share of the output of new original preparations will increase significantly. The development of medicines, which affect the central nervous system, and antibacterial and antiviral preparations, as well as the expansion of the production of hemotherapeutic and radioimmunological preparations are at the center of attention.

The output of new chemical means of plant protection will be expanded, their import from capitalist countries will be reduced significantly, the export of domestic products to socialist and capitalist states will be increased. By the development of the production of intermediate products their import from capitalist countries is being reduced by 30 percent.

Considerable scientific research work is being performed on the increase of the efficiency and the acceleration of the development of the food industry.

In the scientific research programs on the production of food stuffs nondestructive methods of testing and enzymoanalytical methods will be developed, the production of food products of a high nutrient and biological value of a new type will also be reflected. Energy-saving and low-waste technologies of food production, as well as advanced methods of controlling technological processes will be developed.

A special intersectorial program has been prepared for the development of methods of increasing the efficiency of the feeding of animals and the degree of assimilation of protein by them.

A statewide scientific research program is devoted to the increase of the productivity of soils and the increase of the efficiency of the production of biomass. The goal of the research is the reduction by 10-15 percent of the specific reclamation expenditures and the improvement by 8-10 percent of the efficiency of nutrients. The increase of the yield of cereals by 3 billion forints, sunflowers—by 1 billion forints a year, apples—by up to 4-8 tons per hectare, and tomatoes—by 10-20 percent by the further development of the biological principles of plant growing, the enlargement of the gene fund, the development of new high-yielding strains and hybrids, and their improvement is envisaged by the program.

In the food industry production processes are being modernized. The degree of the automation and electronization of equipment is increasing. A special intersectorial program is devoted to the electronization of agriculture. One of the main goals of the program of the development of space methods and advanced equipment of remote sounding is their use for agricultural production.

In the statewide scientific research program on biological technology it is planned to develop traditional microbiological fermentation equipment at the same time as new genetic, enzymological methods. Methods which use systems with programmed properties: methods of growing plant cells and tissues for the cultivation of new resistant strains of plants; the manipulation and transplantation of embryos; the production of enzymes of special types for the food industry; biotechnological processes of obtaining modern vaccines and antibiotics; methods of the biological protection of plants, will be used instead of natural microbiological systems.

Of the problems of the priority direction "Biotechnology," which were stipulated by the Comprehensive Program of Scientific and Technical Progress, 26 Hungarian institutes are taking part in the solution of 17.

The Efficient Production and Consumption of Materials and Energy. Two statewide scientific research programs and three central programs of the development of the economy serve the development of materials- and energy-saving technologies, as well as the reprocessing of waste products.

For these purposes it is proposed by the plan to allocate only 7-8 percent of all the expenditures on capital investments, which are intended for scientific research during the 7th Five-Year Plan. The value of the output, which is produced by means of the reuse of materials, will increase according to the plan from 12 billion to 18-20 billion forints a year.

A separate scientific research program is aimed at the introduction in production of new materials and the improvement of the physical and chemical properties of traditional ones, the modernization of existing technologies, the use of electronic methods for the optimization of the use of materials, and the dissemination of computer-aided design. Of the problems envisaged in the Comprehensive Program of Scientific and Technical Progress 25 Hungarian organizations are participating in joint work on 10 of them. The State Program of Scientific Research and the Development of Hungarian Power Facilities is aimed at the more efficient use of domestic coal deposits, the development of more economical types of power equipment, the recovery of waste products and byproducts as sources of energy, and the use of several nontraditional sources of it (wind, solar, geothermal).

Atomic energy is the basic direction of the development of Hungarian power facilities in the next decades. Therefore, Hungary is extremely interested in its rapid development, which is envisaged by the Comprehensive Program of Scientific and Technical Progress. In all 20 Hungarian institutions and enterprises are participating in joint work on 16 problems in this area. Relying on the positive 15-year experience of activity in Budapest of an international collective of the CEMA member countries for the physics of nuclear reactors, the Hungarian side is prepared to propose the organization of a new joint collective for the development of new, advanced control systems of nuclear electric power plants.

The acceleration of scientific and technical progress in Hungary has become an economic necessity. The directions of technical development, as well as the problems and difficulties in many respects are the same as in other fraternal countries. The Comprehensive Program of Scientific and Technical Progress of the CEMA Member Countries to 2000, which was formulated on the basis of the national plans of the countries of the socialist community, is a powerful tool of the joint solution of the problems of their scientific and technical development.

Footnote

1. Applied research and the development of new technological processes and products, including prototypes, as well as equipment for pilot production are implied by activity which is conducive to technical development.

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END